RQF LEVEL 5

TRADE-LAND SURVEYING

MODULE CODE: LSVGL501

TEACHER'S GUIDE

Module Name: ARC GIS SOFTWARE IN LAND MANAGEMENT

Contents

Acronyms

LAIS :	Land Administration Information System
RNRA :	Rwanda Natural Resources Authority
UN-Habitat :	United Nation Habitat
LTRSP :	Land Tenure Regularization Support Programme
EDPRS :	Economic Development and Poverty Reduction Strategy
MINIRENA :	Ministry of Natural Resources
MINAGRI:	Ministry of Agriculture
NLC :	National Land Centre
NAFA :	National Forestry Authority
ORLT :	Office of Registrar of Land Titles
DLB :	District Land Bureau
DLO :	District Land Office
ID :	Identification Number
UPI :	Unique Parcel Identification
LIS :	Land Information System
FIG :	International Federation for Surveyors
LTR :	Land Tenure Regularization
LTRSS :	Land Tenure Regularization Support System
GIS :	Geographic Information System
SLM :	Sector Land Manager

Introduction

This module describes the skills, knowledge and attitudes required to apply ArcGIS software in land management. At the end of this module, participants will be able to identify land management function and components, perform GIS software in land registration, and perform ArcGIS software in land use planning

A **GIS** is a set of computer tools that allows people to work with data that are tied to a particular location on the earth. Although many people think of a GIS as a computer mapping system, its functions are broader and more sophisticated than that.

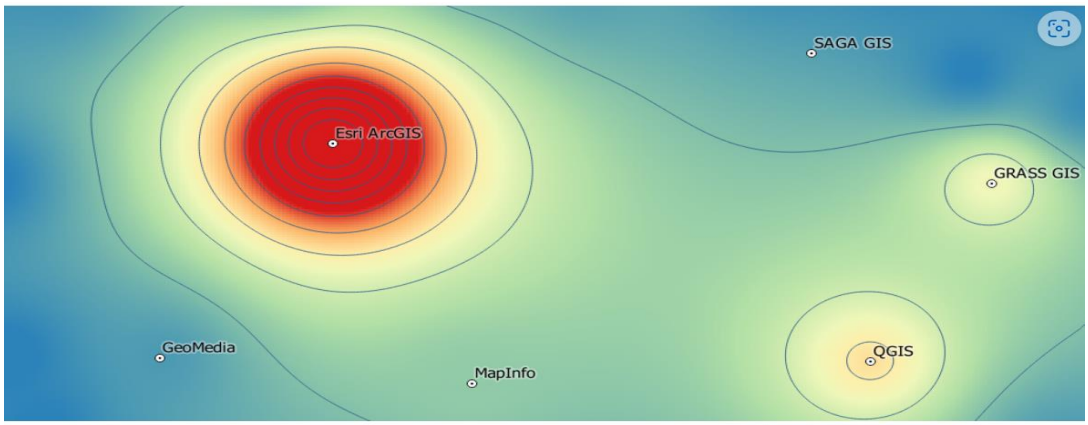
GIS software varies widely in functionality, but any system claiming to be a GIS should provide the following functions at a minimum:

- **Data entry** from a variety of sources, including digitizing, scanning, text files, and the most common spatial data formats; ways to export information to other programs should also be provided
- **Data management** tools, including tools for building data sets, editing spatial features and their attributes, and managing coordinate systems and projections
- **Thematic mapping** (displaying data in map form), including symbolizing map features in different ways and combining map layers for display
- **Data analysis** functions for exploring spatial relationships in and between map layers
- **Map layout** functions for creating soft and hard copy maps with titles, scale bars, north arrows, and other map elements.

The GIS is a tool for better solution of environmental management in Rwanda. Rwanda's environmental resources can be categorized into land, wetlands, forests, and water resources.

In ArcGIS software, you can query data; analyze spatial relationships, such as distance, intersection, and containment among map features; and overlay layers to discover how different types of data are interrelated at a particular location. In addition ArcGIS software offers a full set of spatial analysis tools to perform advanced GIS data analysis, modelling, and data conversion. It also provides high-end cartographic tools and advanced capabilities for data translation, creation, and conversion of a wide range of spatial file formats. Mapping Out the GIS Software Landscape (Price, 2016)

There are a lot of GIS software's (**ArcGIS, QGIS, GRASS GIS, SuperGIS, SAGA GIS, JUMP GIS**…), however ArcGIS developed by ESRI, has a cutting edge in GIS. It raises the bar to the next level by doing what other GIS software can not do. Its success is that it's expandable, from field apps to modelling and scripting



Land management is the process by which the resources of land are put to good effect. It is a system of planning and management methods and techniques that aims to integrate ecological with social, economic and legal principles in the management of land for urban and rural development purposes to meet changing human needs, while simultaneously ensuring the long-term productive potential of natural resources and the maintenance of their environmental and cultural functions. Land administration is the process of determining, recording and dissemination of information about ownership, value and use of land, when implementing land management policies .

GIS technology and cadastral survey software solutions help land information agencies manage cadastre data by providing an adaptable, open system that facilitates the creation of specialized cadastre maps and plans, delivery and integration of spatial data services, leveraging of database information, adherence to legal and information technology standards, sharing and reporting between clients and agencies, and dynamic visualizations that can be used for geographic queries.

Inappropriate land management leads to inefficient exploitation of natural resources, destruction of the land resource, poverty and other social problems, and even to the destruction of civilization. The land is the ultimate source of wealth and the foundation on which civilization is constructed.

Module Code and Title **: LSVGL501 ArcGIS Software In Land Management**

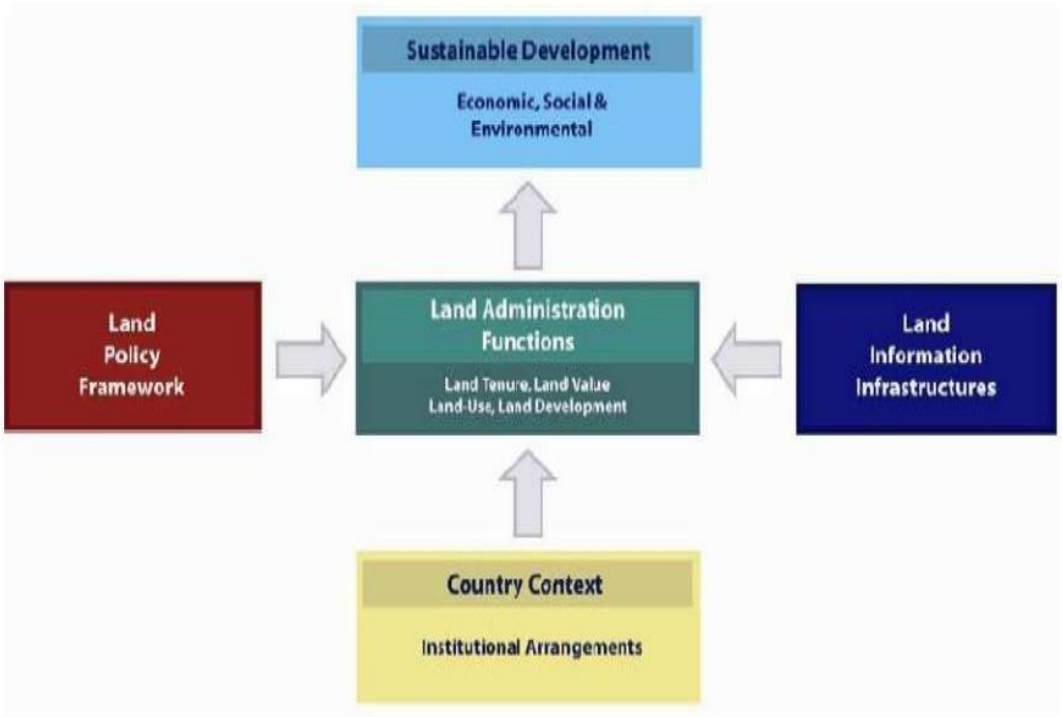
Learning Units:

1 Identify land management components and functions

2 Perform ArcGIS software in land registration

3 Perform ArcGIS software in land use planning

Learning Unit 1: Identify land management components and functions



Source: (Stig Enemark, 2007).

STRUCTURE OF LEARNING UNIT 1

Learning outcomes:

- **1.1** – Identify different land management tools/instrument
- **1.2** – Identify land management components
- **1.3** – Identification of land administration function

Learning outcome 1.1 Identify different land management tools/instrument

Duration: 6.hrs

Learning outcome 1.1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify principles and technics of Land management
2. Demonstrate ArcGIS as a decision support tool
3. Identify different layers of the environment

Resources

Equipment	Tools	Materials
- Projector - Computer	- Whiteboard/ Blackboard -ArcGIS software	- Notebook - Pen - Reference books -Lesson plan - Marker pen - Chalks

Advance preparation:

- A simulating video of different land management tools
- Reference books
- Arrange field visit to land management organisation for example **National Land Authority**

Content 1.1.1: Land management method and techniques

Rwanda's environmental resources are categorized into land, wetlands, forests, and water resources. In most cases, environmental degradation in Rwanda has occurred not by massive exploitation of resources, but by the cumulative effects of subsistence exploitation by an increasing population, coupled with limited alternative options for sustainable livelihoods, the demand to convert more land to agriculture has led to destruction of Rwanda's wetlands, which has resulted in flooding, loss of wildlife habitats and sedimentation, the natural forests had a high degree of biodiversity and rare animal species which was threatened by human encroachment.

- ✓ **Land management**: is the process of managing the use and development (in both urban and rural settings) of land resources. Land resources are used for a variety of purposes which may include organic agriculture, reforestation, water resource management and eco-tourism projects. The principles of land management are:

1. To protect the potential of natural resources and
2. To prevent degradation of soil and water quality (protection) be economically viable (viability) be socially acceptable, and
3. To assure access to the benefits from improved land management (acceptability/equity) (Williamson et al., 2010)

The use of remote sensing and Geographic Information Systems (GIS) in environment management has received considerable attention in the literature.

- ✓ **Arc GIS**: ArcGIS is a GIS software used to create, manage, share, and analyze spatial data. It consists of server components, mobile and desktop applications, and developer tools.

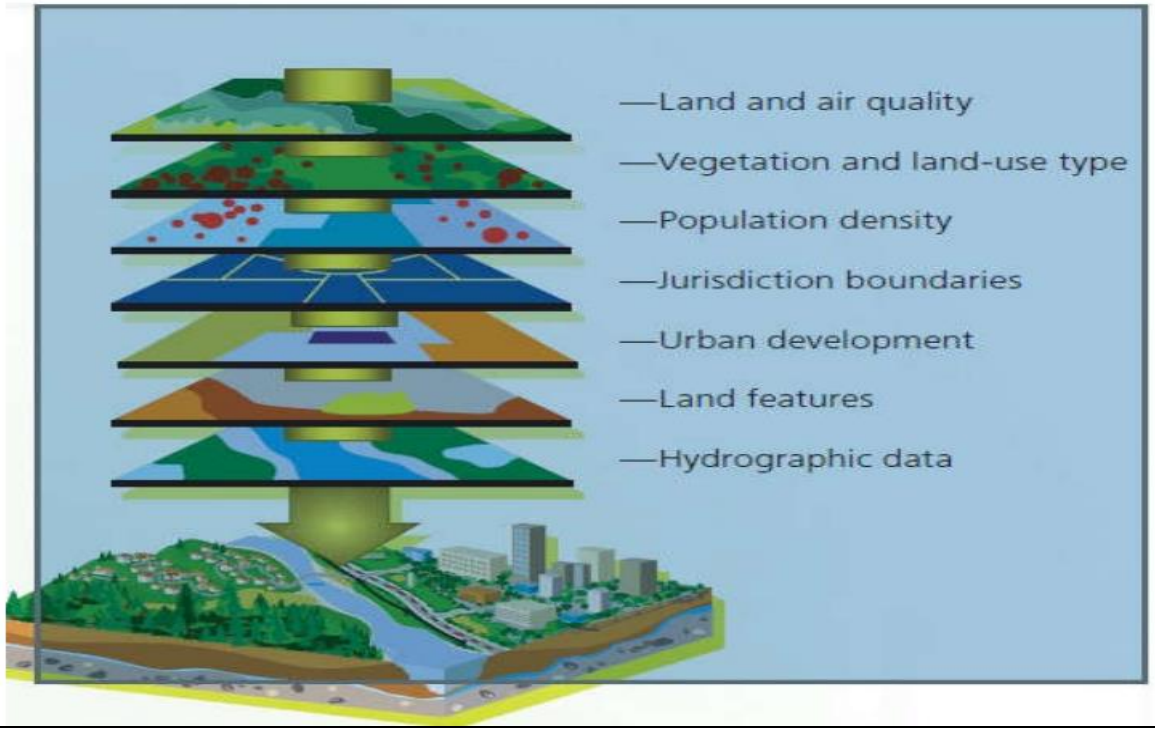


Fig 2:Environment layers *(*Source:(Esri & White Paper, 2013))

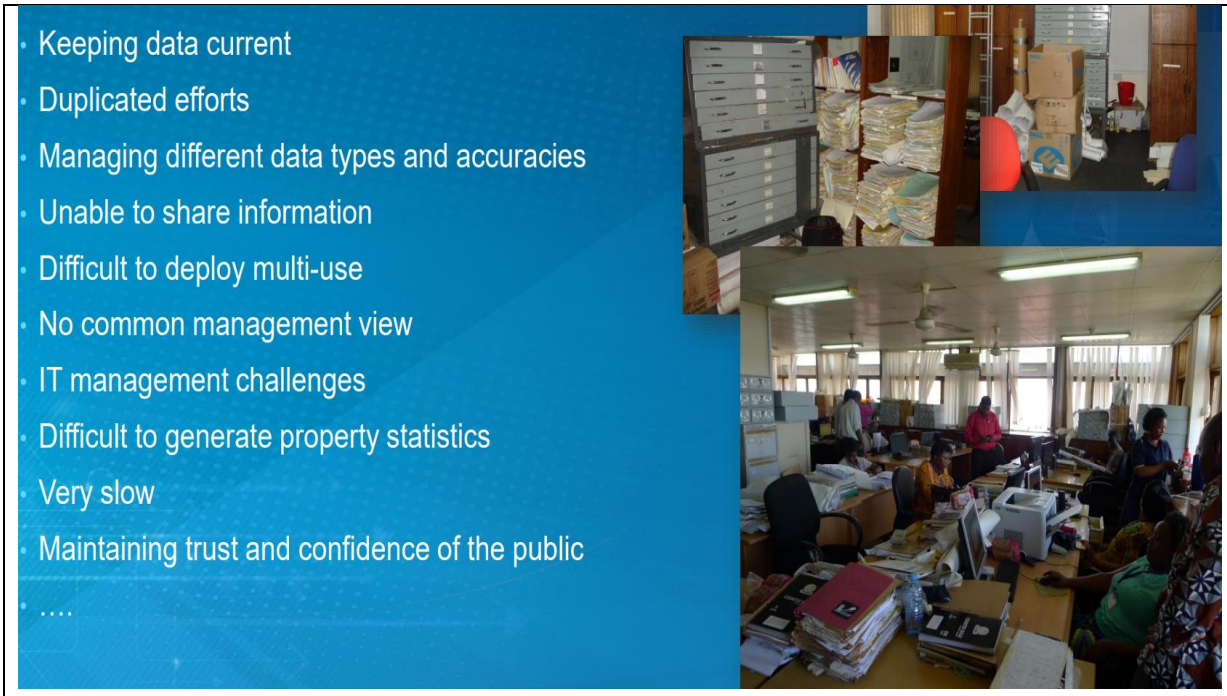
ArcGIS provides a multitude of tools for spatial analysis and modelling, and visualisations that can be used for communication and stakeholder involvement in planning process.

Multiple criteria analysis has been used as a decision support tool for a wide number of applications.

1. **Sustainable land management** involves technology, strategies, and actions that strive to integrate socioeconomic considerations with environmental impacts to:
   - Maintain and improve output
   - Minimise production risk and increase soil capacity to protect from environmental pollutants
   - Safeguard natural resource potential and prevent soil and water quality deterioration
   - Be financially feasible
   - Be socially acceptable while ensuring access to advantages of better land management(Global Environment Facility, 2005)

Source (Esri & White Paper, 2013),

Challenges of Traditional land management methods

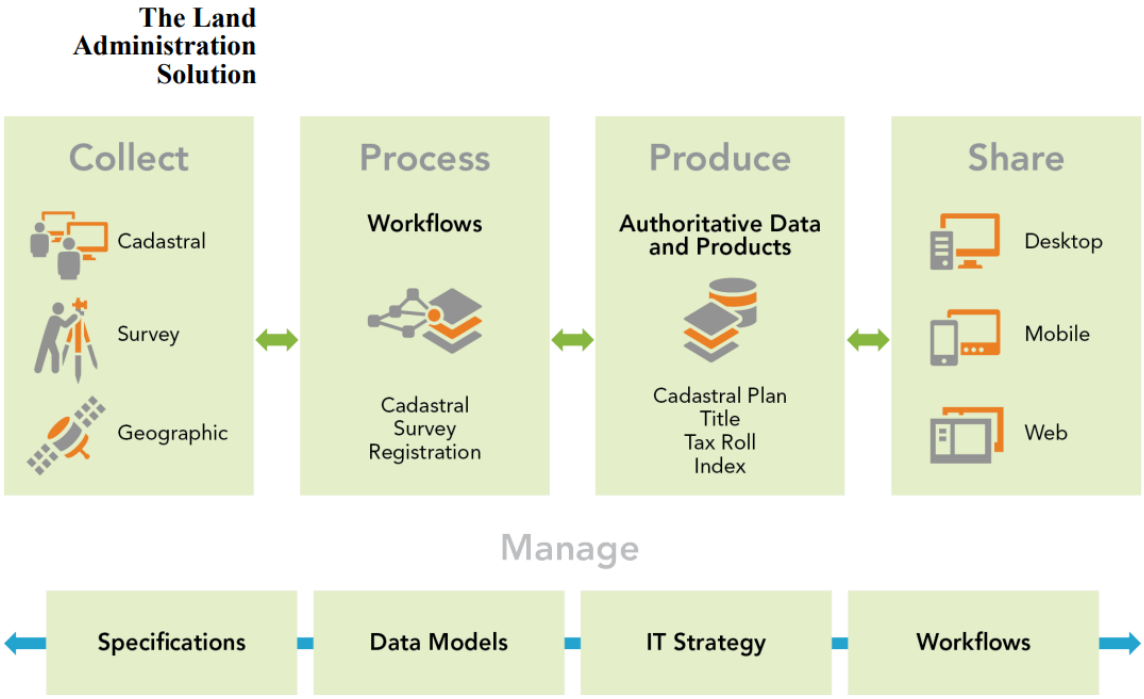


The traditional method of data management has proved to be ineffective and cumbersome. It is faced with problems such as: Redundancy (the unnecessary repetition or duplication of data), High maintenance costs, long learning times and difficulty in moving from one system to another, the possibility that enhancements and improvements to individual files of data will be made in an ad hoc manner, data-sharing difficulties, lack of security and standards and the lack of coherent corporate views of data management

Source:(ESRI® GIS, 2005)

ArcGIS addresses today's ongoing and changing demands of a land administration agency. Advanced analytical and visualization capabilities deliver insight into trends and patterns in land use and value, providing essential capabilities for planning. The ability to manage vast amounts of imagery, vector, and survey data gives access to all users in a fast, easy-to-use

system. Defined parcel workflows allow internal standardization and resource tracking. Online data sharing and viewing capabilities reduce queries in the office and deliver transparency to other organizations as well as the public. Easy web map publishing provides quick and simplified access to authoritative data. All these benefits come from a single system, ArcGIS(Law Michael, 2018).



Source: (World bank, 2015)

- **Collect:** This is the beginning of the data process, where all data, whether collected from cadastral survey with modern land surveying instruments and GPS, digitized from documents, or through feature extraction from aerial photography and satellite imagery
- **Process**: This includes processing collected data; managing parcel and lot information from splits, conveyances, subdivisions, mergers, and other boundary changes; and integrating with other spatial and textural data efficiently
- **Produce:** Many outputs can be configured with data processed and managed including titles, tax rolls, cadastral plans, map books, master address tables, and upto-date websites that deliver only the data users want to deliver, securely
- **Manage:** A well-constructed land administration system provides functionality for managing all the land administration workflows and ensuring accurate and timely data, quality inspection, and reporting

2. Land management methods:

1. **Land taxation:** A land value tax (LTV) is a method of assessing property taxes that only considers the value of the land itself and related improvements, and not the structures built on the land.

2. **Land acquisition:** Land acquisition is a process where government take possession of land for public purposes for its own use or for private entity by paying compensation to its owner.

3. **Land reform:** Land reform involves the changing of laws, regulations or customs regarding land ownership.

Two main objectives of land reform are:

a) To change the agrarian structure in a way as not to obstruct but promote the growth of agriculture; and
b) To replace the old land system by a new one, free from the exploitative features which characterized the former.

Land reforms can be classified as follows:

- Removal of intermediaries between the State and cultivators;
- Providing security of tenure and ownership to the tenants;
- Rationalization of the rent structure;
- Fixation of ceiling on land-holdings and the redistribution of surplus land among landless cultivators; and.
- Consolidation of holdings to transform agriculture into a profitable activity.


Theoretical learning Activity

- ✓ Group discussion on principles of land management
- ✓ Group discussion on different layers of the environment
- ✓ Brainstorm on different on the importance of land management


Practical learning Activity

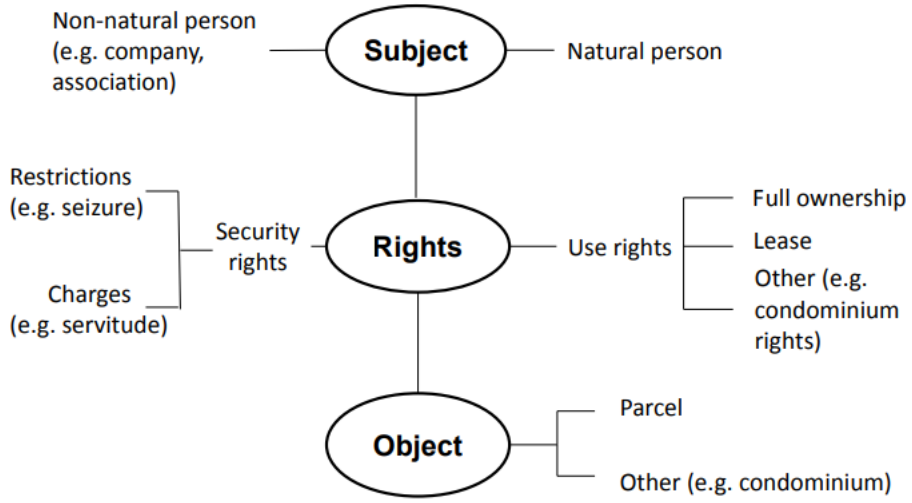
- ✓ Trainees in the computer lab search and download different layers of the environment on internet for Rwanda.


Points to Remember (Take home message)

- ✓ ArcGIS as a decision support tool
- ✓ Land management benefits.
- ✓ Sustainable land management

Content 1.1.2: Land management instruments/tools

1.1.2.a Tools used in Land management:



✓ **Land registration**: Land registration generally describes systems by which matters concerning ownership, possession or other rights in land can be recorded to provide evidence of title, facilitate transactions and to prevent unlawful disposal. land registration Is a system for the recording and providing of information and proof of land registered. Land Registration is about recording land Objects (parcels/condominiums) on which Subjects (natural or non-natural persons) have (legal) Rights, following the existing land legislation. Subjects who are holding property rights will get a land title that can be shown as a proof of having Rights on an Object. Registration of rights on land in Rwanda is mandatory.

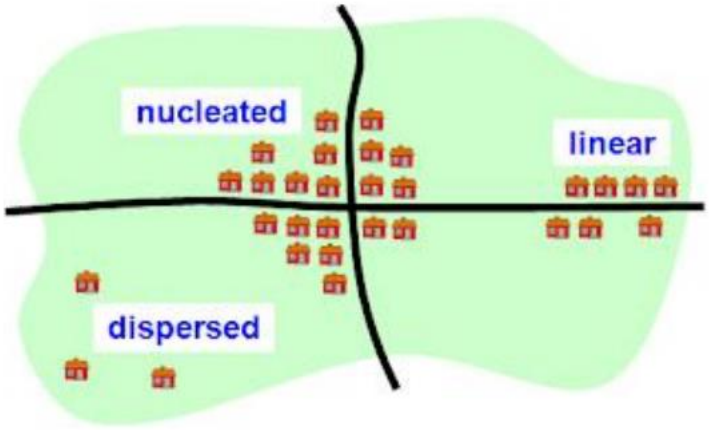
2**. Land consolidation**: Land consolidation is a planned readjustment and rearrangement of fragmented land parcels and their ownership. It is usually applied to form larger and more rational land holdings. Importance of land consolidation:

- It can help in addressing potential conflicts over changes to the use of land.
- Projects can use land consolidation to provide alternative land as compensation to owners of agricultural land designated for other purposes
- It can play an important role in improving rural development.
- It can be used to implement developmental and environmental policies (improving environmental sustainability and agriculture).

The view that land fragmentation gives rise to high costs of production and unproductive farms has been the motivation behind several land reforms and agricultural intensification programmes. In Rwanda, land use consolidation was implemented in 2008 with the overall goal to overcome the effects of land fragmentation by increasing the scale of agricultural yields and stimulating a transformation to a competitive and market oriented agricultural sector (MINAGRI, 2009).

The policy also aims to promote a more productive use of land resources by facilitating the implementation of soil and water conservation practices and by improving the opportunities for and benefits derived from investments in productivity enhancing inputs

3. Grouped settlement :A settlement is a place where people live . But it also includes the people who live there, the buildings, the roads, streets and pathways which link up the buildings in the settlement and through which the people communicate. A settlement is a place where people have come to live and have built homes. The settlement of a group of people is the process in which they settle in a place where people from their country have never lived before. Classification of settlements Settlement are primarily classified according to their pattern, size and housing density. They can also be classified according to the functions they perform. Classification according to pattern There are types of settlement classified according to their pattern, these are, isolated, dispersed, nucleated, and linear.



- An isolated settlement consists of a single farm or house very remote from any other one, usually found in farming or hunting rural communities.
- A dispersed settlement is made up of several houses, scattered or dispersed (as the name implies). One house may be up to one or more kilometres from the next. This type of settlement is common in the Sahel.
- In a nucleated or compact settlement, the buildings are clustered, linked by roads, and the settlement itself may have a nearly circular or irregular shape. Such settlements can be either cultural or urban, depending on the size and the functions they perform.
- A linear or elongated settlement forms a straight or curved line, following a line of movement, such as a road, river, coastline or the foot of an elongated escarpment. This type of settlement is found in rural area, but linear developments may constitute extensions of towns on their outskirts

Finally, the integrated nucleated and linear settlements combines the characteristics of both types of settlement and they are star-like.

Classification according to size and housing density

Size and housing density are used together with settlement functions to classify settlements into major categories i.e. rural and urban.

-Rural settlements are often small in size and have low housing and population densities.
-Urban settlements are larger in size and have many houses built close together.

Urban settlements can equally be graded into four, according to size. These are towns, cities, conurbations and megapolis.

- ❖ Towns are urban settlements of up to several thousand persons.
- ❖ Cities are the major towns of a country, like the major state capitals which have administrative functions.
- ❖ A conurbation grows when two or more towns or parts have grown and joined together to form a large urban area of 1 million persons or thereabouts.
- ❖ Megapolis are several cities or conurbations which have grown over the years and have joined together to form a massive sprawling urban settlements.

The function of a settlement helps to identify the economic and social development of a place and can show its main activity.

4. Land law and policy: Land law is the form of law that deals with the rights to use, alienate, or exclude others from land. A land policy can be defined as a set of rules and guidelines that govern how a country's administration will govern, manage and administer land in that country.

The aim of Land Policy are:

- to promote and ensure a secure land tenure system,
- to encourage the optimal use of land resources, and
- to facilitate broad-based social and economic development without upsetting or endangering the ecological balance of the environment.

5. Master plan: A master plan is a dynamic long-term planning document that provides a conceptual layout to guide future growth and development. Master planning is about making the connection between buildings, social settings, and their surrounding environments. A master plan includes: Analysis, recommendations, and proposals for a site's population, economy, housing, transportation, community facilities, and land use. It is based on public input, surveys, planning initiatives, existing development, physical characteristics, and social and economic conditions.

Roles Master planning:

- Develop a phasing and implementation schedule and identify priorities for action
- Act as a framework for regeneration and attract private sector investment.
- Conceptualize and shape the three-dimensional urban environment.
- Define public, semiprivate, and private spaces and public amenities.
- Determine the mix of uses and their physical relationship.
- Engage the local community and act as builder of consensus.

The Process of Developing a Master Plan:

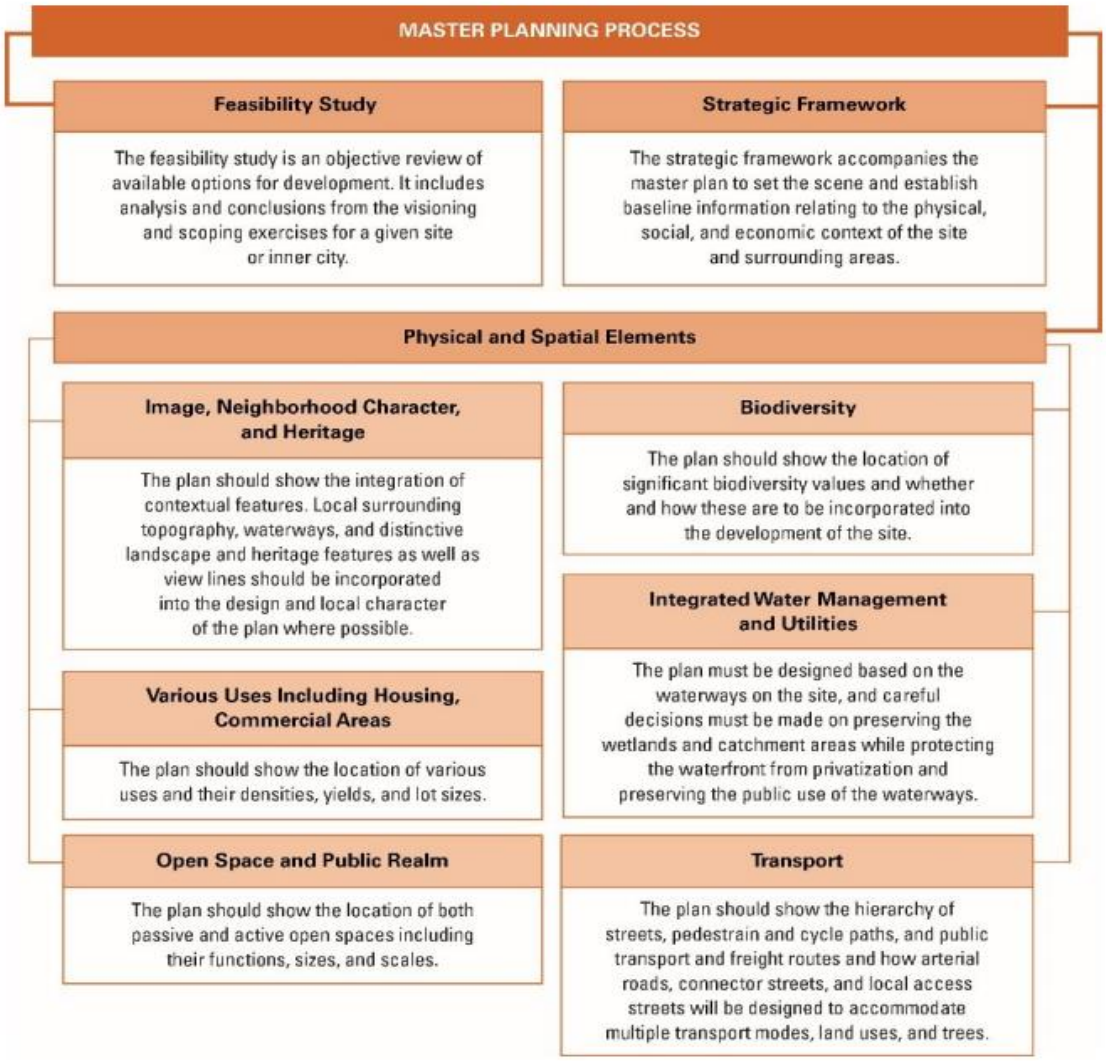
a) **Feasibility Study**: The feasibility study is an objective review of available options for development.

b) **Strategic Framework**: The strategic framework accompanies the master plan and sets the scene in establishing baseline information related to the physical, social, and economic context of the site and surroundings.

The strategic framework includes are:

- Physical aspects of the regeneration project
- Vision and scope prepared during the scoping phase
- Various elements or functions that could act as catalysts for change
- The business case for development
- Strategic delivery issues and options
- Guidelines about how the strategic framework will inform and impact design (CABE 2008)

c) **Physical and Spatial Elements of a Master Plan**: Once the feasibility study and strategic framework have been undertaken, the physical master planning process continues. (Image, neighbourhood character, and heritage, Various uses including housing and commercial areas, Open space and the public realm, Biodiversity, Integrated water management and utilities, Transport. Zero grazing Slope: a field covered with grass or herbage and suitable for grazing by livestock.



Source: (Buenos et al., 2015)

7. Land use policy: Land Use Policy is a set of rules and guidelines that govern how a country's administration will govern, manage and administer land in that country.

The Rwandan Government, found it compelling and necessary to establish a National Land Policy that would guarantee a safe and stable form of land tenure, and bring about

a rational and planned use of land while ensuring sound land management and an efficient land administration. This policy was adopted in 2004 and revised in 2019


Theoretical learning Activity

- ✓ In a Group of 4, trainees discuss on subject-rights-object relationship
- ✓ Group discussion on different types of settlement
- ✓ Brainstorm on different on tools of land management


Points to Remember (Take home message)

- ✓ Types of land management tools
- ✓ Master plan development process
- ✓ Land policy


Learning outcome 1.1 formative assessment

1. Discuss the term sustainable land management**.**
2. List five (5) challenges of the traditional land management methods
3. Describe the master plan development process.

Answers :

1. **Sustainable land management** involves technology, strategies, and actions that strive to integrate socioeconomic considerations with environmental impacts to:
   - Maintain and improve output
   - Minimise production risk and increase soil capacity to protect from environmental pollutants
   - Safeguard natural resource potential and prevent soil and water quality deterioration
   - Be financially feasible
   - Be socially acceptable while ensuring access to advantages of better land management
2. Challenges of the traditional land management methods are
   - Keeping data current
   - Duplicated efforts
   - Managing different data types and accuracies
   - Unable to share information
   - Difficult to deploy multi-use
   - No common management view
   - IT management challenges
   - Difficult to generate property statistics

- Very slow
- Maintaining trust and confidence of the public

3. Master plan developing process

a) **Feasibility Study**: The feasibility study is an objective review of available options for development.

b) **Strategic Framework**: The strategic framework accompanies the master plan and sets the scene in establishing baseline information related to the physical, social, and economic context of the site and surroundings.

The strategic framework includes are:

- Physical aspects of the regeneration project
- Vision and scope prepared during the scoping phase
- Various elements or functions that could act as catalysts for change
- The business case for development
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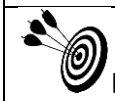
Learning outcome 1.2 Identify land management components

 **Duration: 8.hrs**

 Learning outcome 1.2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify benefits of sound land administration practices

2. Identify components of land management

 **Resources**

Equipment	Tools	Materials
- Projector - Computers -Computer lab	- Whiteboard/ Blackboard -ArcGIS software	- Books - Pen - Reference books - Trainee manual -Lesson plan , Marker pen - Chalks

 **Advance preparation:**

- ❖ Tools, materials and equipment are available
- ❖ Classroom is prepared

Content 1.2.1: Components of land management

PILLARS OF THE LAND MANAGEMENT

1**. Land use planning, surveying, and mapping**: in this pillar, one of the proposed major changes is a shift from a district boundary-based planning to a sectorial and land suitability based planning

2. **Land Use Management**: this pillar provides guidance on how to efficiently use and manage all the available lands across sectors as per the national land use and development master plan and sector level land use master plans

3. **Land administration**: in this pillar, the policy orientation is to strengthen the current land administration system, effective administration of land related fees and real property taxes, reduce land related disputes, enforce the land sub-sector coordination and develop a dynamic institutional arrangement to enhance the governance of the land sub-sector (Ministry of Lands, 2019).

COMPONENTS OF LAND MANAGEMENTS ARE:

1. **Land administration:** Land administration is the process of determining, recording and dissemination of information about ownership, value and use of land, when implementing land management policies.

The benefits of a good land administration are:

- Guaranty of ownership and security of tenure
- Reduce land disputes
- Provide security for credit (mortgages)
- Support for land and property taxation
- Contribute to develop and monitor land markets
- Protect state land
- Facilitate land reform
- Improve urban planning and infrastructure development
- Support sustainable management of land resources and environmental management

The Broader Benefits of Responsible Land Administration		
• Support for governance and rule of law • Alleviation of poverty • Security of tenure • Support for formal land markets • Security for credit	• Support for land and property taxation • Protection of state lands • Improvement of land use planning • Management of land disputes	• Development of physical infrastructures • Management of natural resources • Management of information and statistical data

Adapted from Williamson et al. 2010

(Enemark, 2023)

2. **Land development**: Land development means the construction or modification of improvements to real property that creates additional residential dwelling units within the Town or that results in non-residential uses that create a need for new, expanded, or improved public facilities within the Town.

3. **Land law and policy:** Land law is the form of law that deals with the rights to use, alienate, or exclude others from land. In many jurisdictions, these kinds of property are referred to as real estate or real property, as distinct from personal property. A land policy is essentially an expression of a government's perception of the direction to be taken on major issues related to land.

Theoretical learning Activity

- ✓ Group discussion on benefits land administration
- ✓ Brainstorm on the importance of land policy

Points to Remember (Take home message)

- ✓ Land development
- ✓ Land law and policy
- ✓ Land administration

Learning outcome 1.2 formative assessment

1. What are the three (3) pillars of land management in Rwanda ?
2. List components of land management
3. State benefits of good land administration system

Answers

1.The three (3) pillars of land management in Rwanda

- **Land use planning, surveying, and mapping**
- **. Land Use Management**
- **Land administration**

2.Components of land management

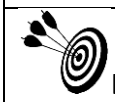
- **Land development**
- **Land law and policy**
- **Land administration**

3.Benefits of good land administration system

- **Guaranty of ownership and security of tenure**
- **Reduce land disputes**
- **Provide security for credit (mortgages)**
- **Support for land and property taxation**
- **Contribute to develop and monitor land markets**
- **Protect state land**
- **Facilitate land reform**
- **Improve urban planning and infrastructure development**
- **Support sustainable management of land resources and environmental management**

Learning outcome 1.3 Identification of land administration function

 **Duration: 6.hrs**

 Learning outcome 1.3 objectives:

By the end of the learning outcome, the trainees will be able to:

4. Identify land administration functions
5. Understand land administration components
6. Identify steps in land adjudication
7. Understand cadastre types

Resources		
Equipment	**Tools**	**Materials**
- Projector - Computer	- Whiteboard/ Blackboard	- Notebook - Pen - Reference books - Marker pen - Chalks

Advance preparation:

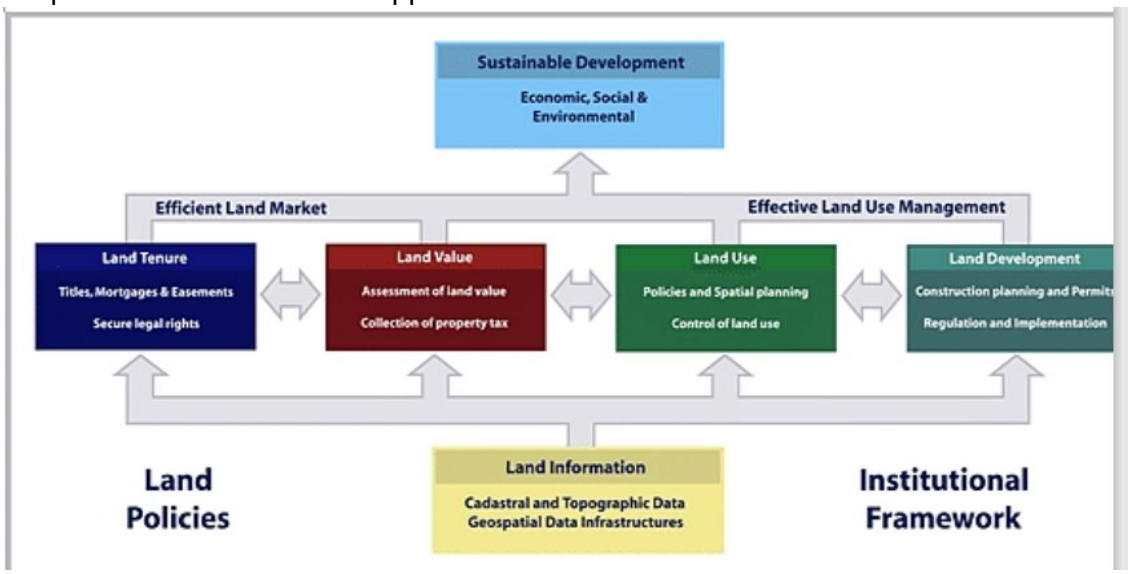
- ~~Tools, materials and equipment are available~~
- Classroom is prepared
- Lesson plan

Content 1.3.1: land administration functions

- ✓ **Land value:** Land value is the measure of how much a plot of land is worth, not counting any buildings but including improvements such as better drainage. When a landowner pays taxes on her real estate, part of what is taxed is the value of the land, in addition to whatever structures sit atop it. Land valuation requires information from three sources:
  - Land
  - Land use.
  - Economics- Information on economics has to be as much as possible very current. This is due to the fact that economic indices are usually very dynamic and evolution process should as much as possible reflect these prevailing situations
- ✓ **Land use:** Land use is the function of land – what it is used for. Land use varies from area to area.
- ✓ **Land tenure**: land tenure is the legal regime in which land is owned by an individual, who is said to "hold" the land. It determines who can use land, for how long and

under what conditions. Tenure may be based both on official laws and policies, and on informal customs(Land law, 2013).

- ✓ **Land development**: In an economics context, land development is also sometimes advertised as land improvement or land amelioration. It refers to investments making land more usable by humans. Land development means the erection of buildings or structures on land, or the change of use of land, including township establishment, the subdivision or consolidation of land or any deviation from the land use or uses permitted in terms of an applicable land use scheme.



Land administration functions. Source (Wyatt & Ralphs, 2003)

Content 1.3.2: land administration component

- ✓ **land adjudication:** Land Adjudication has been defined as the process through which existing rights in a particular parcel of land are finally and authoritatively ascertained. Land adjudication is the process of final and authoritative determination of the existing rights and claims of peoples to land

five steps in the adjudication process

The five steps are:

1. The initial processing review.
2. The automatic review.
3. The manual review.
4. The payment determination.
5. The payment.

- ✓ **land registration:** Land registration generally describes systems by which matters concerning ownership, possession, or other rights in land can be recorded (usually with a government agency or department) to provide evidence of title, facilitate transactions and, prevent unlawful disposal.

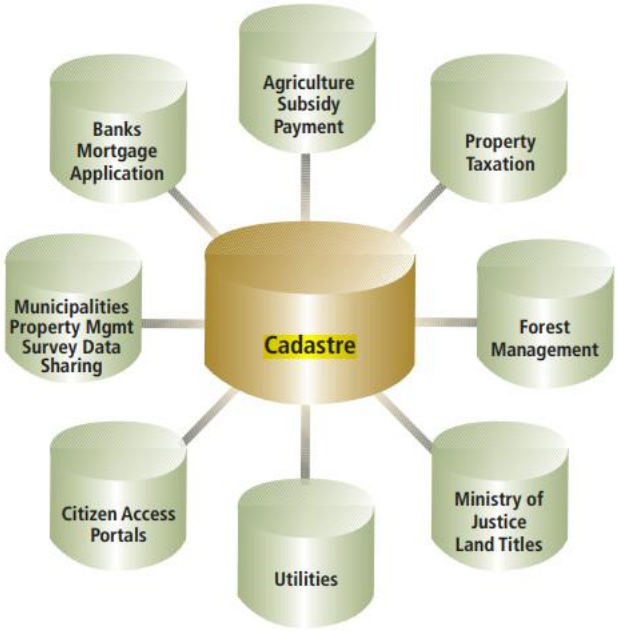
- ✓ **cadastral surveying and mapping:** Cadastral surveying is the discipline of land surveying that relates to the laws of land ownership and the definition of property boundaries. Cadastral surveys are generally performed to subdivide land into parcels for ownership under a land title and to re-establish boundaries of previously surveyed properties to determine the physical extent of ownership or to facilitate the transfer of the property title. **The purpose of cadastral surveying?** It provides a ready means of precise description and identification of particular pieces of land and it acts as a continuous record of rights in land. A modern cadastre normally consists of a series of large-scale maps or plans, and corresponding registers.

Mapping is making a map, A map is a graphical representation of natural and artificial features on plane surface (2D) and at a specific scale of surface/part of the earth or whole earth. The features are positioned as accurately as possible usually relative to a coordinate reference system

- ✓ **A cadastre** is an official, legal documentation concerning the quantity, dimensions, location, value, tenure, and ownership of individual parcels of land.

Types of cadastre

a) **Judicial (or legal) Cadastre**: It records the proprietary (ownership) interest on land; it includes information on the ownership, area and location; it provides evidences for legal actions such as subdivision, boundary re-establishment and conflict resolution.
b) **Fiscal Cadastre**: It is compiled for purposes of raising revenues (taxes), it relates to the usage and quality of land. Usage may be agricultural, residential, commercial, industrial, etc. and Quality may be the productivity of the land.
c) **Multipurpose Cadastre** is described as the one combining the judicial and fiscal cadastres, and links additional land attribute data to the parcels. The term 'multi-purpose cadastre' means about the same as the term 'land information system' (LIS). Therefore, the main components of such a system are a spatial reference structure, a topographic map base, a cadastral map overlay showing land parcels with various land information linked with them.

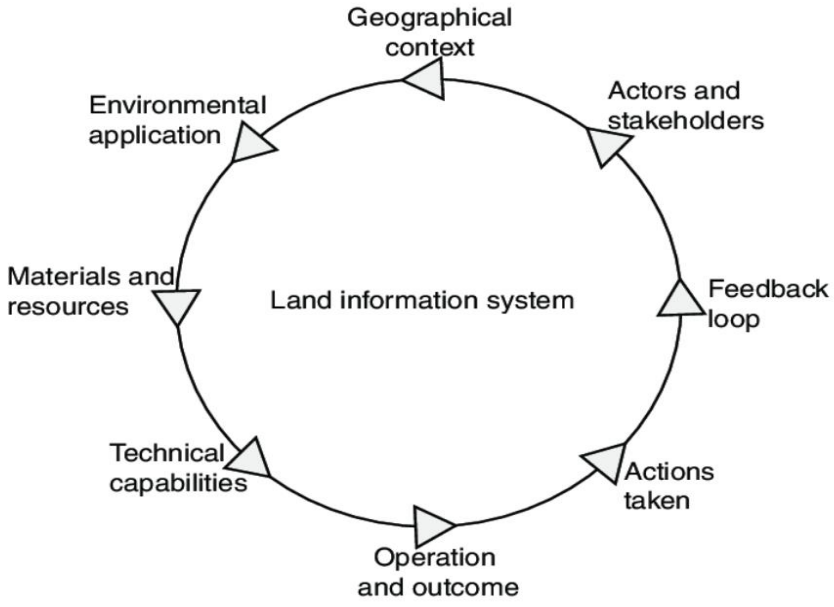


The multipurpose cadastre uses GIS to access and process data throughout public and private organisations.

Source(ESRI® GIS, 2005)

- ✓ **land information systems:** A land Information System (LIS) is a geographic information system for cadastral and land-use mapping, typically used by local governments. A LIS consists of an accurate, current and reliable land record cadastre and its associated attribute and spatial data that represent the legal boundaries of land tenure and provides a vital base layer capable of integration into other geographic systems or as a standalone solution that allows data stewards to retrieve, create, update, store, view, analyze and publish land information.

The Land Information System (LIS) Lifecycle



ArGIS helps land information agencies fulfill a variety of these services, from producing specialized maps to providing complex schemes for integrating and delivering spatial data services under the modern mode of e-government.

Advantages of Computer-Based Databases

1. Different data access methods will be possible.
2. Data are stored independently of the application for which they will be used.
3. Redundancy will be minimized
4. Access to data will be controlled and centralized
5. A computer database is relatively easy to maintain and updating is possible

6 Simple query systems and standardized query languages are available (Osaka & Premadasa, 2014).


Theoretical learning Activity

- ✓ Group discussion on benefits of good land administration practices
- ✓ Group discussion on land management systems
- ✓ Brainstorm on land adjudication procedures in Rwanda


Points to Remember (Take home message)

- ✓ What is Land adjudication
- ✓ What is Land registration
- ✓ What is Land development.
- ✓ A cadastre

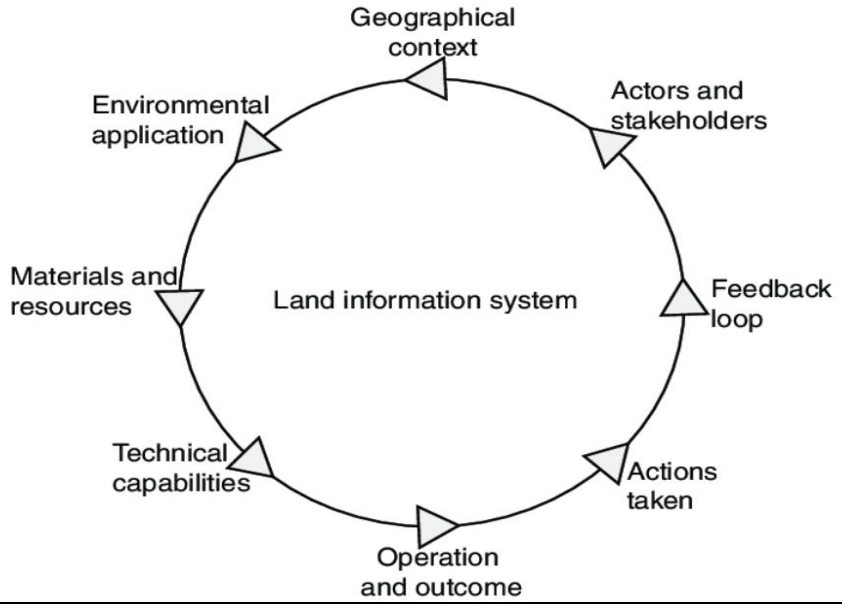

Learning Unit 1.3 Formative Assessment

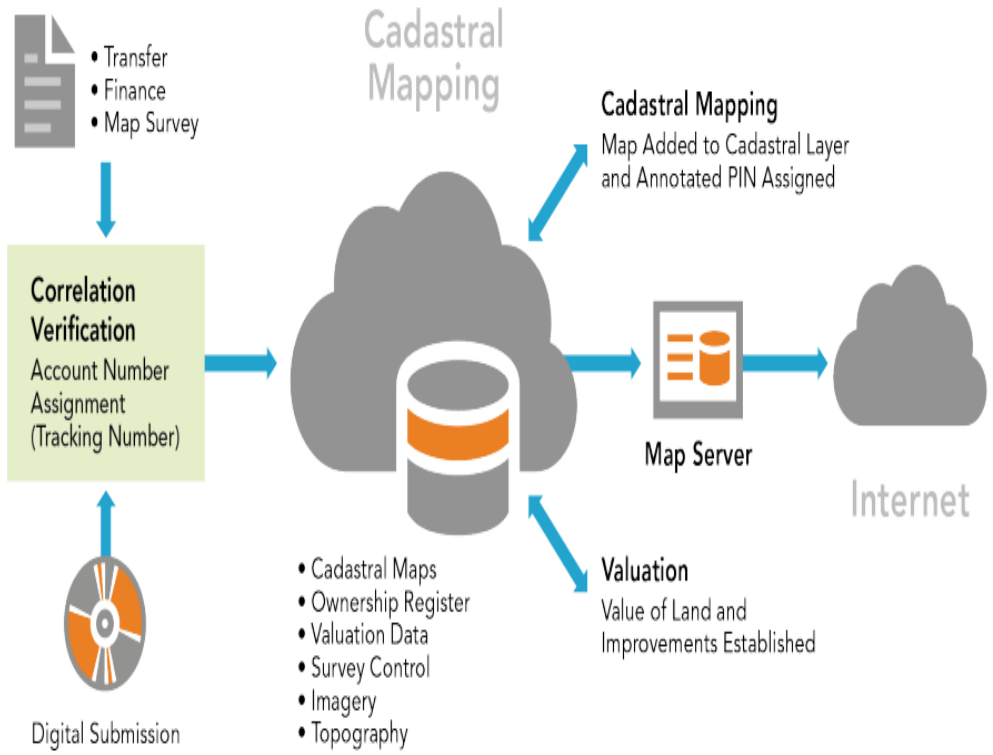
1. List any three (3) GIS software packages other than ArcGIS software.
2. Define the term land tenure.
3. Define the term cadastre
4. List three (3) types of cadastre
5. Draw and label the land information system (LIS) lifecycle.

Answers

1. **Geomap, MAPINFO, QGIS, GRASS GIS, SuperGIS, SAGA GIS, JUMP GIS**

2. **Land tenure**: land tenure is the legal regime in which land is owned by an individual, who is said to "hold" the land. It determines who can use land, for how long and under what conditions. Tenure may be based both on official laws and policies, and on informal custom
3. **A cadastre** is an official, legal documentation concerning the quantity, dimensions, location, value, tenure, and ownership of individual parcels of land
4. **Types of cadastres are:**
    - **Judicial (or legal) Cadastre**: It records the proprietary (ownership) interest on land; it includes information on the ownership, area and location; it provides evidences for legal actions such as subdivision, boundary re-establishment and conflict resolution.
    - **Fiscal Cadastre**: It is compiled for purposes of raising revenues (taxes), it relates to the usage and quality of land. Usage may be agricultural, residential, commercial, industrial, etc. and Quality may be the productivity of the land.
    - **Multipurpose Cadastre** is described as the one combining the judicial and fiscal cadastres, and links additional land attribute data to the parcels
5. land information system (LIS) lifecycle





Example of a Workflow within ArcGIS for Land Administration

Source : (ESRI® GIS, 2005)

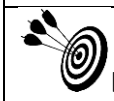
STRUCTURE OF LEARNING UNIT 2

Learning outcomes:

2.1– Identify land registration documents
2.2- Identify parcel location
2.3 – Produce deed plan documents
2.4– Produce index map

Learning Outcome 2.1 Identify land registration documents

 **Duration: 8.hrs**

 Learning outcome 2.1 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify types of land registration
2. Identify documents for land registration
3. Understand function of land registration.

 **Resources**

Equipment	Tools	Materials
- Projector - Computers	-Whiteboard/ Black board -ArcGIS software	- Books - Notebook - Pen - Reference books - Deed documents - Title documents

 **Advance preparation:**

- Tools, materials and equipment are available
- Classroom is prepared
- ArcGIS Software installed

Content 2.1.1: Land registration documents

Documents of Land registration

The documents required for registration of land are:

- ✓ **Deed plan:** Deed plan is an extract or reduction of the survey plan to be used in certificate of title. Itis a plan drawn on or attached to any kind of a deed. A deed is a formal written document that has force in law to alter the rights and duties of the parties to it.
- ✓ **Title**: A land title or certificate of title is a formal document outlining the rights a person or people hold in a piece of property. A title is a bundle of rights in a piece of property in which a party may own either a legal interest or equitable interest.
- ✓ **Tax Declaration of the property:** Tax is the tax on real property imposed by the Local Government Unit (LGU). The legal basis is Title II of the Local Government Code (LGC),

The tax base of the immovable property is the surface of a plot of land and the market value of any buildings, including improvements.

- ✓ **Parcel cadastral plan**: is generally a large-scale map of an area showing all of the property parcels and their use, the boundaries and the distance between them and the buildings and improvements.

Content 2.1.2: Types of land registration

- ✓ **Deed registration**: Deeds registration is a land management system whereby all important instruments which relate to the common law title to parcels of land are registered on a government-maintained register.
- ✓ **Title registration**: title is a land registration and land transfer system, in which a state creates and maintains a register of land holdings, which serves as the conclusive evidence (termed "indefeasibility") of title of the person recorded on the register as the proprietor (owner), and of all other interests recorded on the register

Content 2.1.3: Function of land registration

The purpose of land registration:

- ❖ It creates a clear record of ownership which clearly sets out any matters that affect the property, such as rights of way and restrictive covenants.
- ❖ It provides greater protection against claims for 'Adverse Possession', more commonly known as squatting and makes them easier to defeat.

The benefits of land registration:

- ❖ It helps you to protect your land from fraud and to resist third party applications for adverse possession over your land and property.
- ❖ It also safeguards against the title deeds being lost, damaged or destroyed.

- **Function of land registration:**

✓ **Identification of the land parcels:** A land-parcel identification system (LPIS) is a system to identify land use for a given country. It utilizes orthophotos (basically aerial photographs and high precision satellite images that are digitally rendered to extract as much meaningful spatial information as possible).

✓ **Verification of the interest:** An interest in land is a right (or a "bundle" of rights) that someone has in, against, under or over - or with respect to - a parcel of land. If the person holding the interest in land is the current owner of the land itself, then the "interest" means "simply" ownership of that land**.**

✓ **Identification of the owner**: A landowner is a person who owns land, especially a large amount of land. Rural communities involved in conflicts with large landowners

✓ **Identification of the interest**: Identity of Interest means a situation in which a Project Participant has a direct or indirect interest in the ownership of an entity which contracts with a Project Participant to provide land, goods or services for the project.

✓ **Increase of the proprietary protection available to the interest**: A proprietary interest refers to the legally enforceable right to possess or use property in accordance with an official recognition of that right.

✓ **Transaction facilitation**: Transaction Facilities means the credit facility established under this Agreement, the Existing Revolving Credit Agreement, the Existing Term Loan Credit Agreement and the Takeout Financing.

✓ **Proof of registration**: Certificate of provisional land ownership (cell, signed and stamped).

✓ **Temporary certificate for systematic land registration.**

Theoretical learning Activity

- ✓ Group discussion on documents of land registration
- ✓ Group discussion on purpose of land registration
- ✓ Brainstorm on challenges of land registration in Rwanda

Points to Remember (Take home message)

- ✓ Deed plan
- ✓ Function of land registration
- ✓ Benefits of land registration

Learning outcome 2.1 formative assessment

1. State two (2) types of land registration
2. List two (2) benefits of land registration
3. Outline any five (5) functions of land registration.

Answers

1. Two (2) types of land registration
   - **Deed registration**:
   - **Title registration**
2. Two (2) benefits of land registration
   - **It helps you to protect your land from fraud and to resist third party applications for adverse possession over your land and property.**
   - **It also safeguards against the title deeds being lost, damaged or destroyed**
3. Five (5) functions of land registration
   - **Identification of the land parcels:**
   - **Verification of the interest**
   - **Identification of the owner**:
   - **Identification of the interest**
   - **Increase of the proprietary protection available to the interest**:
   - **Transaction facilitation**:.
   - **Proof of registration**:
   - **Temporary certificate for systematic land registration.**

Learning Outcome 2.2 Identify parcel location

Duration: 8.hrs

Learning outcome 2.2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Create shape files
2. Convert features to shapefiles
3. Differentiate digital maps from hardcopy(paper) maps.
4. Identify Parcel identification elements

Resources

Equipment	Tools	Materials
- Projector - Computers	-Whiteboard/ Black board -ArcGIS software	- Books - Notebook - Pen - Reference books - Lesson plan, - Deed documents

Advance preparation:

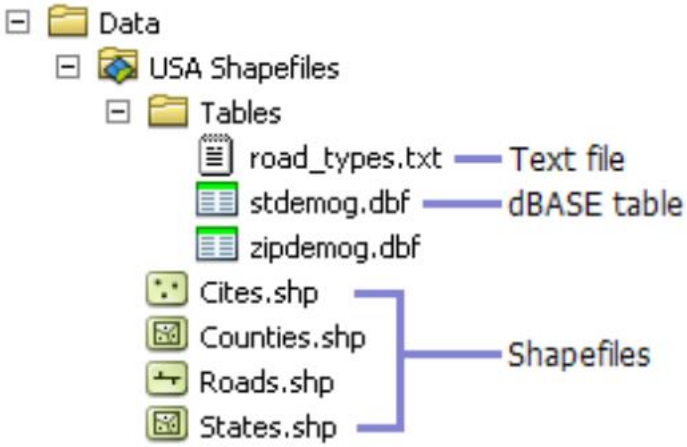
- Tools, materials and equipment are available
- Classroom is prepared
- ArcGIS Software installed
- Lesson plan prepared

Content 2.2.1: GIS Data

GIS data needed in Land management:

- ✓ **Parcellation shapefile**
  - Parcellation: is the division into parcels
  - A Shapefile is a digital vector storage format for storing geometric location and associated attribute information.

Below is an example of how shape files appear in Arc Catalog:



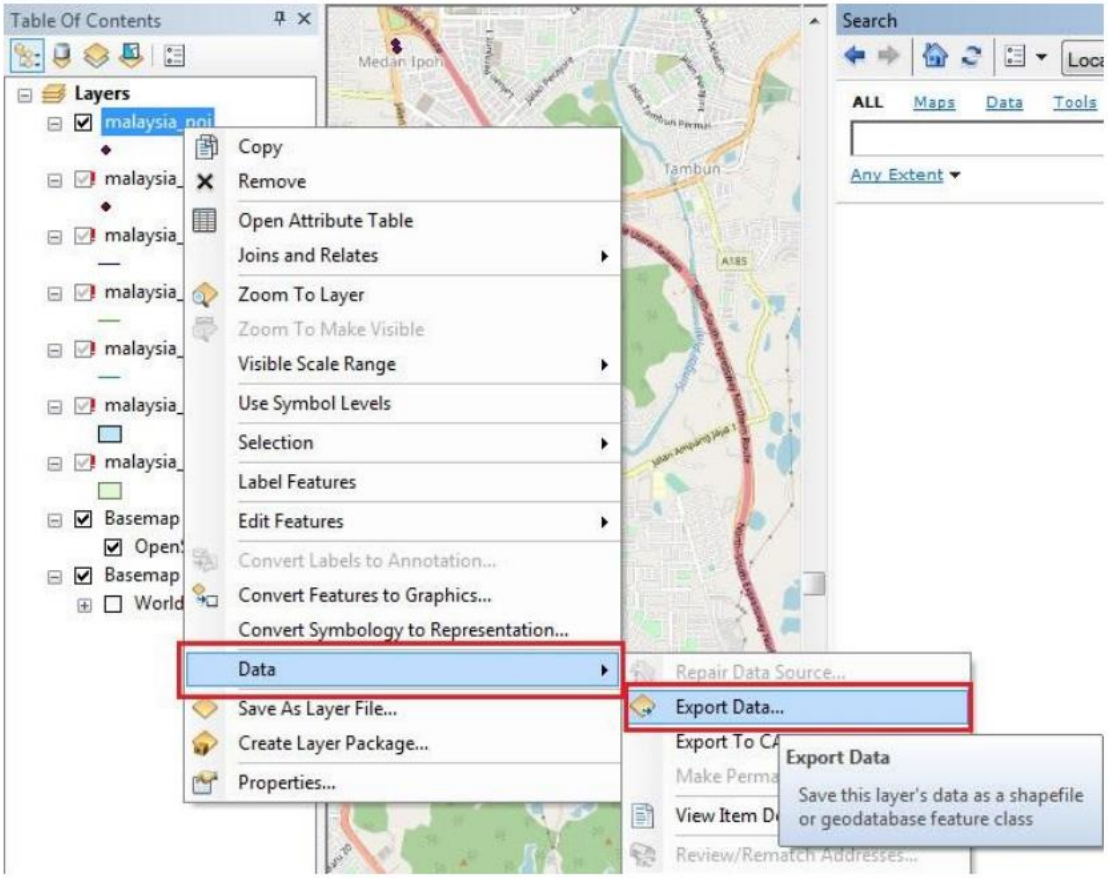
How To: Convert selected features to a shapefile in ArcMap

Instructions provided describe how to convert the selected features of a layer to a new shapefile in ArcMap using the Export Data feature.

Procedure

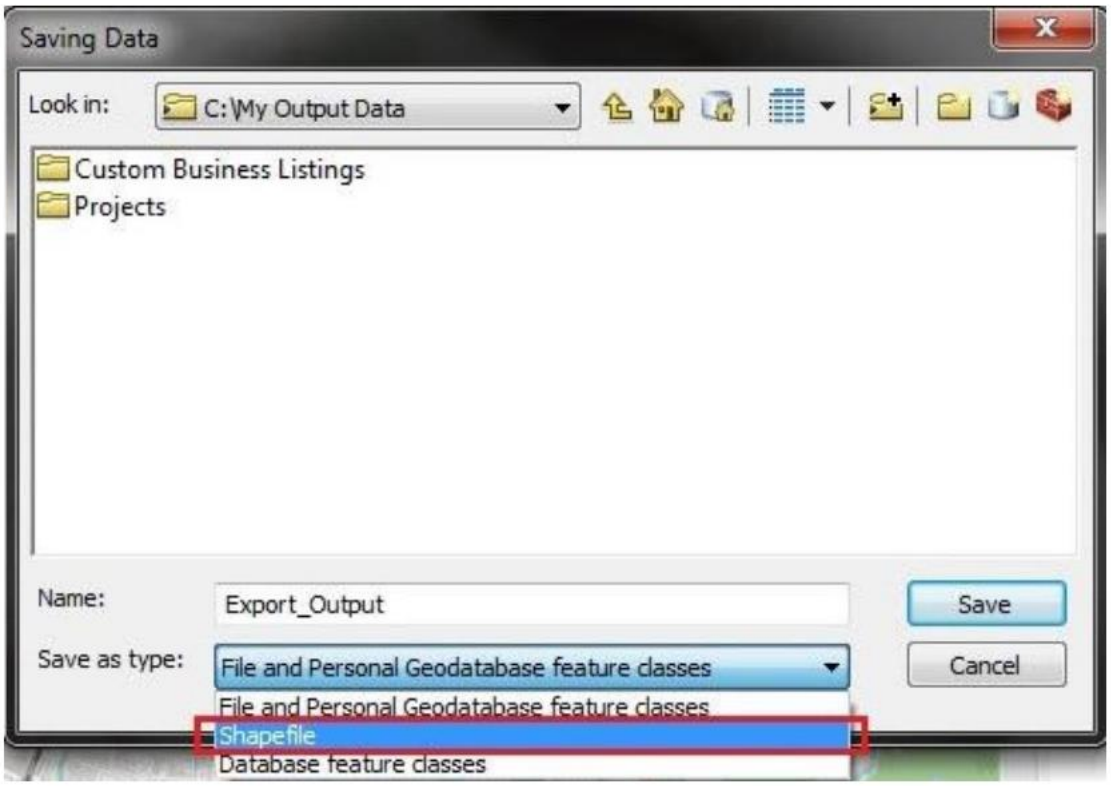
Follow the steps below:

1. In ArcMap, use any of the methods available in the selection menu, or use the Select Features tool to manually select the features of the layer to be converted.
2. In the Table of Contents, right-click the name of the layer with the selected features to convert.
3. Select Data and then Export Data to open the Export Data dialog box



4. From the Export drop-down list, select and click Selected Features.
5. Click the Browse button next to the Output Feature Class text box

6. In the Saving Data dialog window, select the output folder. Name the output and from the Save as type drop-down list, select Shapefile. Click Save.



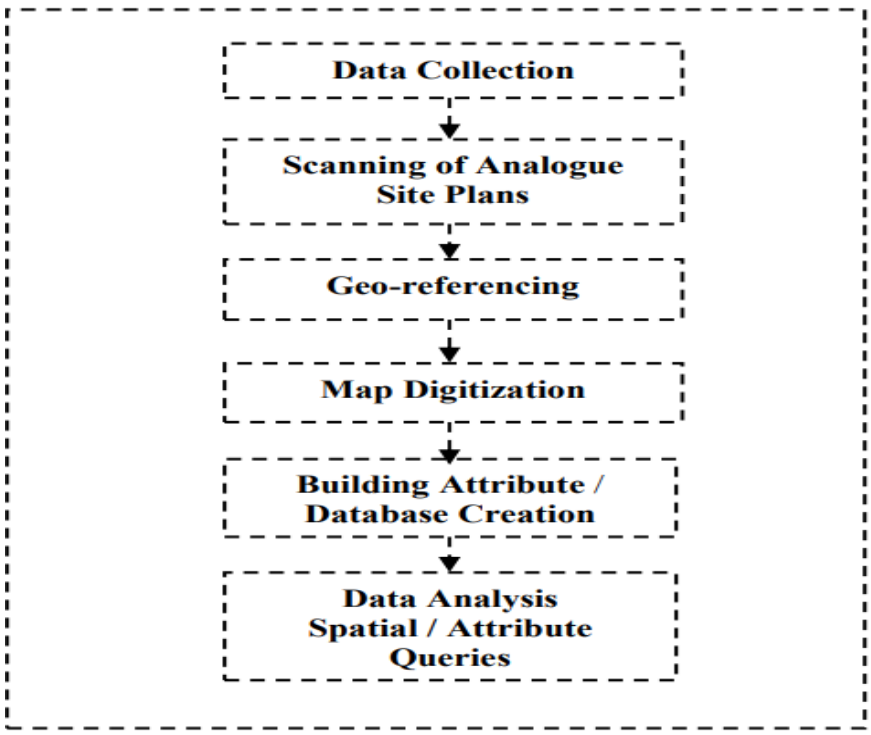


Figure 1. – Flowchart of procedures

Database Creation / Building Attribute

Database is a collection of data organized for storage in a computer memory and designed for easy access by authorized users. The data may be in the form of text, numbers, or encoded graphics. Since their first, experimental appearance in the 1950s, databases have become so important in industrial societies that they can be found in almost every field of information.

In GIS, two types of data are handled – the graphical data and non spatial attribute data. These types of data are normally stored in a database. During digitizing the attributes of each feature class are added to the features so that it can be easily identified and to enable querying.

This can be done before digitizing or after digitizing. The procedures for digitizing are stated as follows:

1. Right-click the layer in the table of contents.
2. Click Open Attribute Table The Attributes of the table will display three columns named FID, Shape, and ID, all of which were created by ArcMAP.
3. In the Attributes table click Options, Add Field. If you are unable to select this option, go back to the Editor Toolbar, click Stop Editing, and then try again to add a field.
4. In the Name field, type PLOT NO, choose Short Integer From the Type drop-down list, then click OK
5. Click Editor, Start Editing, click in the top cell of the PLOT NO field, type 1, and press Enter Pressing Enter will not take you to the next cell. To activate the next cell for data entry, place your mouse cursor over it and click.
6. In sequential order, continue numbering the remaining cells in the PLOT NO field.
7. Click Editor, Stop Editing.
8. Click Yes to save your edits

Geospatial Database Queries

These involve the extraction of relevant information from sets of spatial and attribute data. Queries offer a method of data retrieval, and can be performed on data that are part of the ArcGIS database.

The following queries can be performed on the database:

- Summary of Property Attributes.
- Which properties have a building type of “3 Bedroom Detached bungalow”.
- Which properties have an area that is greater than 557.479 sq. meters?.
- Which properties have not paid their annual ground rent?
- Which properties are used for commercial purposes?
- Which properties have not been sold?
- Which properties have a market value that is less than RWF500,000.00?

The difference between a shape file and a layer:

A shape file is stored in a set of related files and contains one feature class. but a layer file is a just a link\reference to actual data, such as a shape file, feature class, etc. It is not actual data because it does not store the data's attributes or

geometry. A primary advantage of shape files is that this simple file structure draws faster than a coverage does.

✓ **Administrative shape file**
Administrative shapefiles contain boundaries of standard geographic locations The administrative shapefiles provided here are in ESRI shapefile format and are contained in self extracting WinZip EXE files.

✓ **Orthophoto:** An orthophoto is an aerial photograph that has been geometrically corrected or 'orthorectified' such that the scale of the photograph is uniform and utilized in the same manner as a map. An ortho-photograph can be used to measure true distances of features within the photograph.

Orthophoto maps and Digital Elevation Model (DEM can be used to produce:

A. Classified forest map

B. Soil map

C. Land use map:

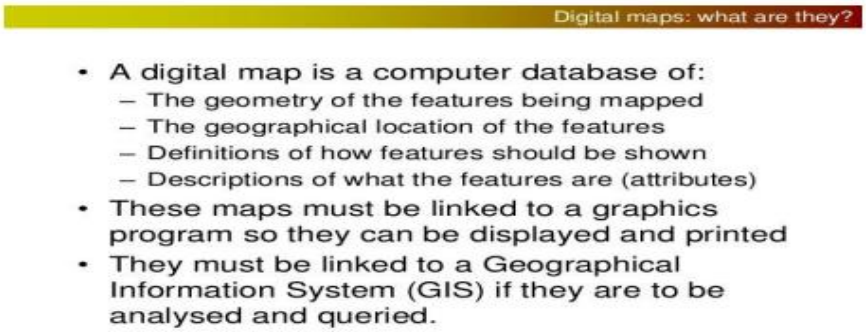
- ❖ Land use / Land cover maps,
- ❖ Land use change maps: Comparing between Orthophoto maps and satellite images
- ❖ Land use planning

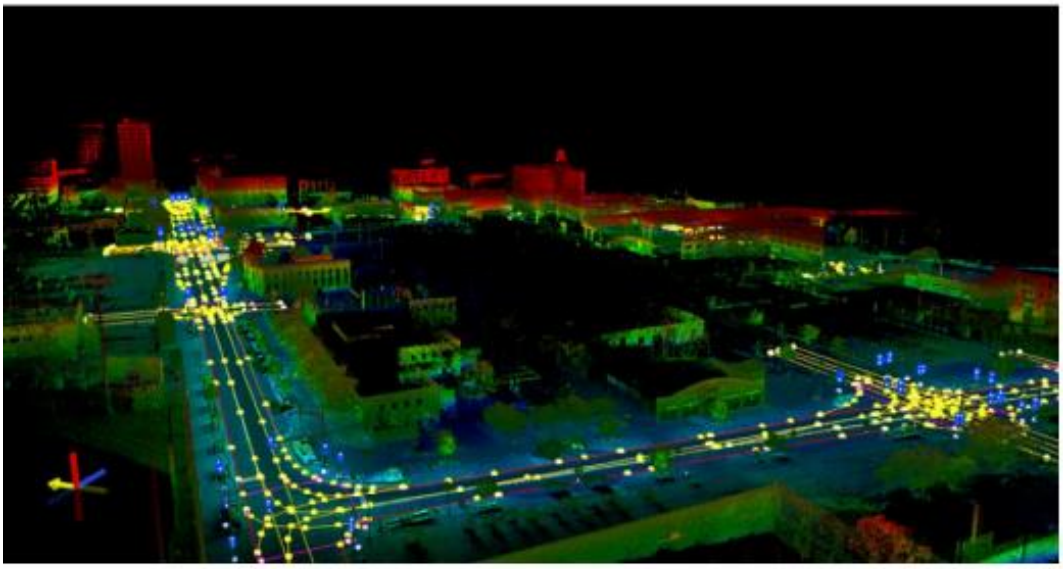
D. Erosion hazards maps

E. The other government sections outside LDD: Land Development Division (various locations) such as Ministry of Transportation, Ministry of Resources and Environment, Department of Public Works and Town & Country Planning, Department of Land Digital elevation model (DEM)

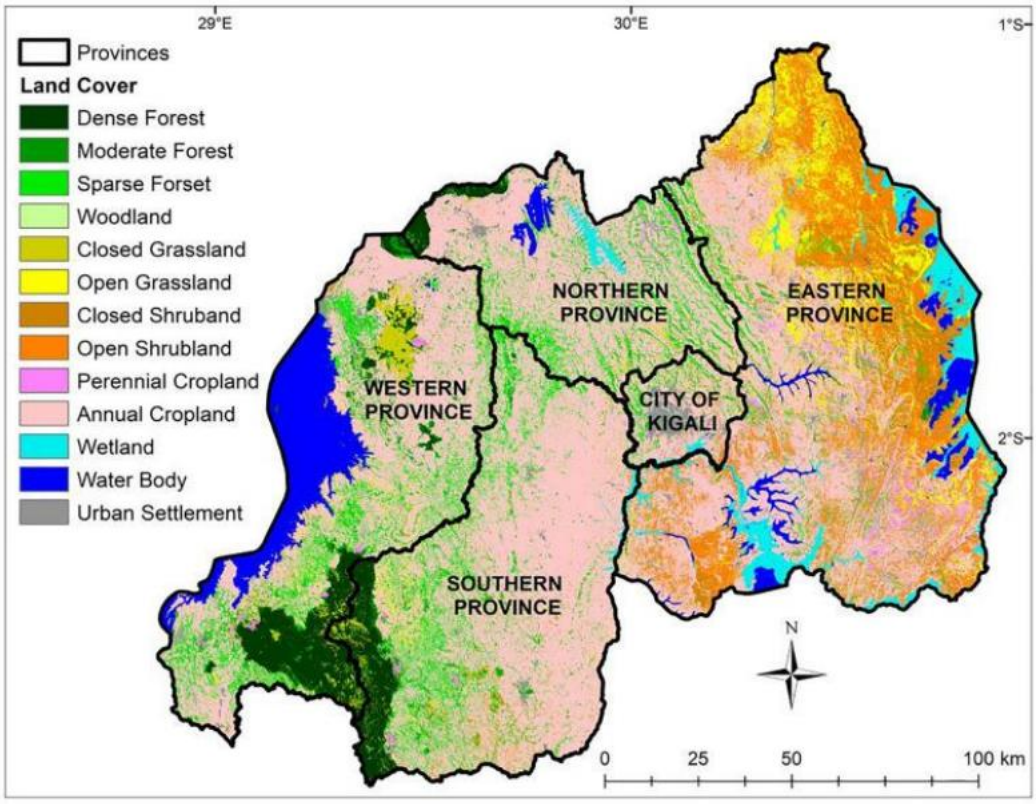
- ❖ Extract watershed boundary
- ➢ Extract erosion model's parameters (1. Rain map)

✓ **Digital and hard copy maps**





Paper maps are static representations of features on land at the time when the representations were created. ... Paper maps are limited to specific area based on the scale of the map: Paper maps are representations that are limited on a specific area of the land and not the entire geographical location (Tyner Judith, 2010).



Source (MINISTRY OF INFRASTRUCTURE, 2016)

Differences between paper maps and digital maps

Digital maps	Paper maps
They can be downloaded for free	They can be bought physically on physical stores
Storage requires digital space	Storage requires physical space
Digital maps must be accessed online	Paper maps can be accessed offline
Shows all features including time and the actual building	Mostly uses symbols to represent features and routes
Can be easily updated	Cannot be updated easily:
It is dynamic:	It is static
Digital maps can represent all features at the same time	Paper maps cannot represent all features at the same time
Digital maps are not limited to any area	Paper maps are limited to specific area based on the scale of the map
May not require special skills since it shows the real life object	It requires skills to interpret because of the symbolic representation of features
Good at showing area overlays from various angles	Good at showing boundaries and for data analysis
Cannot be used to show changes in land forms because it is always up to date	It is important for use as data storage and for comparison of change in landforms

 Theoretical learning Activity

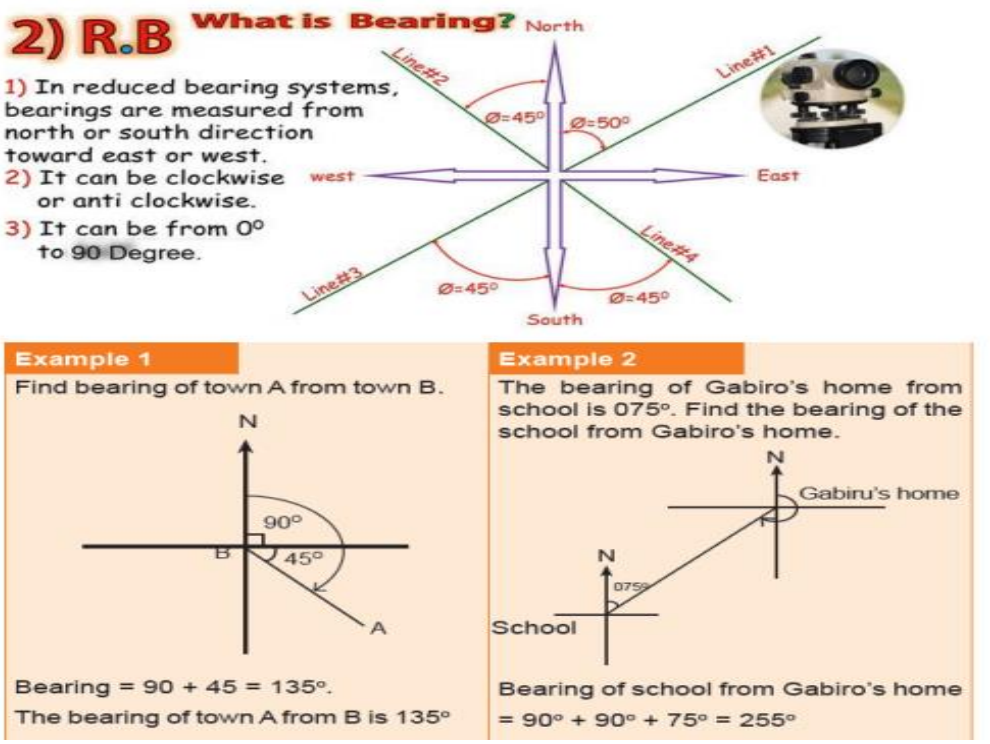
- ✓ Group discussion on ArGIS shapefile
- ✓ Group discussion on features and layers in ArcGIS
- ✓ Brainstorm on differences between digital maps and paper (hardcopy) maps

 Points to Remember (Take home message)

- ✓ Feature
- ✓ Layer
- ✓ Differences between paper maps and digital maps

Content 2.2.2: Parcel identification elements

- ✓ **Owne**r : A landowner is a person who owns land, especially a large amount of land.
- ✓ **Use**: Land use refers to the purpose the land serves, for example, recreation, wildlife habitat or agriculture; it does not describe the surface cover on the ground. Land use is the characterization of land based on what can be built on it and what the land can be used for.
- ✓ **Location** : Land use is the characterization of land based on what can be built on it and what the land can be used for. A location is the place where something happens or is situated .
- ✓ **Area** : the area can be defined as the space occupied by a flat shape or the surface of an object.
- ✓ **Beacons coordinates**: Beacons can be considered as permanent survey marks of any kind, and is made of concrete, iron or stone, and includes pillars and boundary posts so made. Beacons are used to demarcate the actual boundaries between one settlement and another. They are surveying tools and are of different sizes and types. The beacon must have the X,Y,Z coordinate which indicate the exact position of the beacon
- ✓ **UPI (Universal Personal Identification) Number** : is a method of identifying the location of a parcel containing a unique series of numbers for state, division/district, county/city/town, section and lot number. Example of UPI: 1/04/05/06/12345 UPI Application. The UPI application displays the information of Land Administration Codes and Names along with spatial information starting from the state, division/district, county/city/town, section for all states
- ✓ **Bearing**



Theoretical learning Activity

- ✓ Group discussion on parcel identification elements
- ✓ Group discussion on calculating bearings and distances between points
- ✓ Brainstorm on different types of bearings

Practical learning Activity

- ❖ Trainees to collect land parcel data using GPS or total station and enter in ArcGIS

Points to Remember (Take home message)

- ✓ Parcel identification elements
- ✓ Bearing (forward and back)

Learning outcome 2.2 formative assessment

1. in groups create different types of shapefiles, (point, line, polygon) in ArcGIS software

Answer

1. **Trainer to asses whether learners can create different shapefiles in ArcGIS software**
   - **Point**

   Line

   polygon

Learning Outcome 2.3 Produce deed plan documents

Duration: 8.hrs

Learning outcome 2.3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify deed plan elements
2. Understand deed plan format
3. Identify field data needed to produce deed plan
4. Produce a deed plan in ArcGIS

Resources

Equipment	Tools	Materials
- Projector - Computers	-Whiteboard/ Black board -ArcGIS software	- Books - Notebook - Pen - Reference books

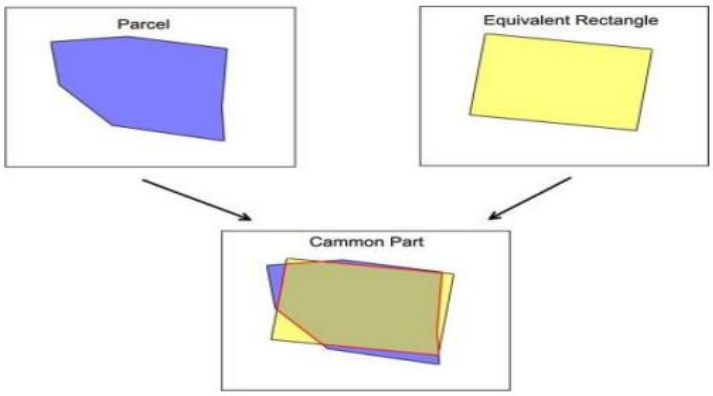
Advance preparation:

- ❖ Tools, materials and equipment are available
- ❖ Classroom is prepared
- ❖ ArcGIS Software installed
- ❖ Lesson plan

Content 2.3.1: Deed plan content

Deed plan Elements are:

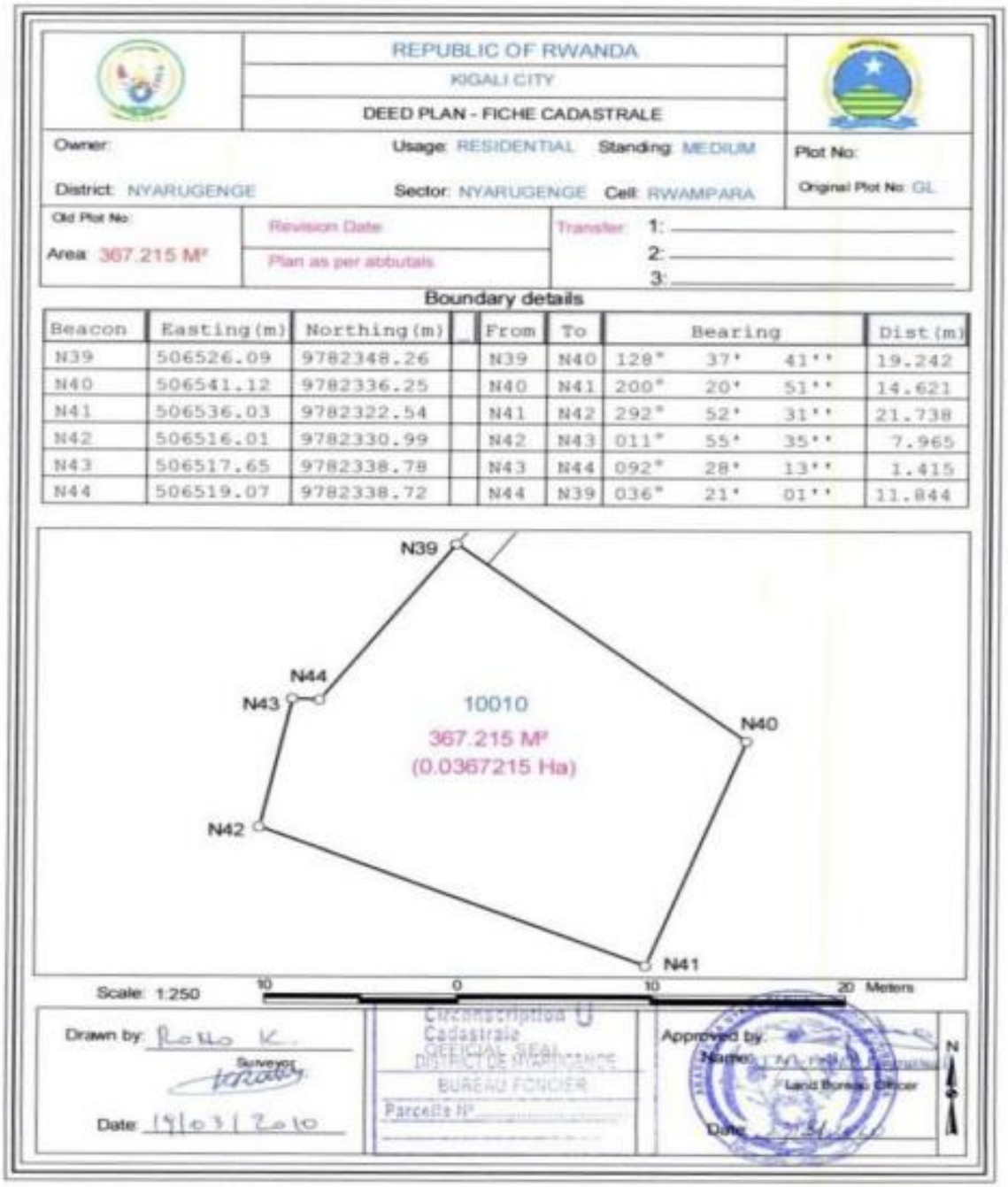
- **Logos of office of land registrar of title:** Logos is when we use cold arguments – like data, statistics, or common sense – to convince people of something, rather than trying to appeal to an audience's emotions.
- **UPI number** : To identifying the location of a parcel containing a unique series of numbers for state, division/district, county/city/town, section and lot number.
- **Land owner** : person who owns land
- **Land use** : the function of land. Land use varies from area to area
- **Plan doc number**: The number given to a document by its originators to be used as a means for retrieval; it will follow any one of various systems, such as chronological, subject
- **Area** : the extent or measurement of a surface or piece of land.
- **Boundary details**: a line or something else that marks a limit or border.
- **Geometry figure of the parcel**:The figure which show how the percel is take positioned



- **Location**: Province, District, Sector, cell
- **Survey date** : Which show the day on which the survey is carried out
- **Coordinate system** : is a system designed to establish positions with respect to given reference points. The coordinate system consists of one or more reference points, the styles of measurement (linear or angular) from those reference points, and the directions (or axes) in which those measurements will be taken.
- **Scale** : The scale of a map is the ratio of a distance on the map to the corresponding distance on the ground.

- **Surveyor details**: names, signature and stamp of the surveyor
- **District officer approver**: Approving Officer means the subdivision approval official appointed for that purpose under the provisions of the Land Title Act.

Content 2.3.2: Deed plan format



REPUBLIC OF RWANDA

KIGALI CITY

DEED PLAN - FICHE CADASTRALE

Owner:

Usage: RESIDENTIAL Standing: MEDIUM

Plot No:

District: NYARUGENGE Sector: NYARUGENGE Cell: RWAMPARA

Original Plot No: GL

Old Plot No:

Area: 367.215 M²

Revision Date:

Plan as per abbutals

Transfer: 1: 2: 3:

Boundary details

Beacon	Easting(m)	Northing(m)		From	To	Bearing			Dist(m)
N39	506526.09	9782348.26		N39	N40	128°	37'	41''	19.242
N40	506541.12	9782336.25		N40	N41	200°	20'	51''	14.621
N41	506536.03	9782322.54		N41	N42	292°	52'	31''	21.738
N42	506516.01	9782330.99		N42	N43	011°	55'	35''	7.965
N43	506517.65	9782338.78		N43	N44	092°	28'	13''	1.415
N44	506519.07	9782338.72		N44	N39	036°	21'	01''	11.844

Scale: 1:250 10 0 10 20 Meters

Drawn by: Rwo K.

Surveyor

Date: 19/03/2010

Approved by:

Name:

Land Bureau Officer

Date:

N

Content 2.3.3: Field data needed to produce a deed plan:

- **Coordinate of corners parcel**: Parcel corners are the endpoints of parcel lines and they are common between adjacent parcel boundaries. The parcel corner coordinates are not intended to provide the true legal representation of a cadastral parcel.
- **Distances** : the length of the space between two points.
- **Recognizable features data** :To identify all features found on the ground like(roads, rivers)

Necessary Components for the ArcGIS land management database

1. Survey Reference Frame
2. Current, Accurate Large Scale Maps
3. Cadastral Data/Map
4. Unique Parcel Identifier (PIN) on All Properties
5. Land Data which includes PIN


Theoretical learning Activity

- ✓ Group discussion on deed plan elements
- ✓ Group discussion on field data needed to produce deed plan
- ✓ Brainstorm on how to draw deed plan in ArGIS software


Practical learning Activity

- Trainees to produce a deed plan in ArcGIS (Measure coordinates in the field and draw a sample deed plan)


Points to Remember (Take home message)

- ✓ deed plan elements
- ✓ field observations needed to produce a deed plan

Learning outcome 2.3 formative assessment

Mr Jacob intends to subdivide a rectangular land parcel 30m by 40m into two (2) equal plots of 15m×20m, for the purpose of giving to his two children as gifts.

The leaners are requested to produce deed plans of the subdivided plots by using surveying instruments; ArcGIS software, tools and materials.

Answer

checklist

Indicator: Deed plan format	**Yes**	**No**
• Paper based format		
• Digital based format		
Indicator: Field data needed	**Yes**	**No**
• Coordinate of corners parce		
• Distances		
• Recognizable features data (roads, rivers)		
• Coordinate of corners parcel		
Bearing		
Neighbor land parcel location		
Indicator: Deed plan content	**Yes**	**No**
• Logos of office of land registrar of title		
• UPI number		
• Land owner		
• Land use		
• Area		
• Boundary details		
• Geometry figure of the parcel		
• Location: Province, District, Sector, cell		
• Survey date		
• Coordinate system		
• Scale		
Surveyor details: names, signature and stamp		

Learning Outcome 2.4 Produce index map

Duration: 6.hrs

Learning outcome 2.4 objectives:

By the end of the learning outcome, the trainees will be able to:

- Identify the use and the elements of index map

Resources

Equipment	Tools	Materials
- Projector - Computers	-Whiteboard/ Black board -ArcGIS software	- Notebook - Pen - Reference books - Deed documents - Title documents

Advance preparation:

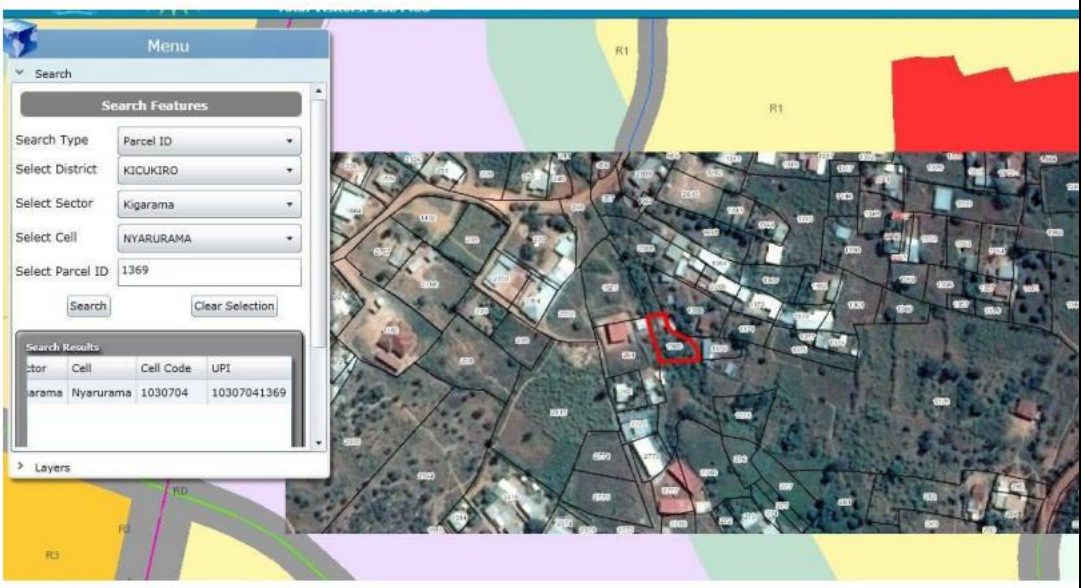
- Tools, materials and equipment are available
- Classroom is prepared
- ArcGIS Software installed

Content 2.4.1: Index maps

Index maps: Index maps are a type of finding aid that enables users to find a set of maps covering their regions of interest along with the name or number of the relevant map sheet. An index map provides geospatial data on either a sheet of paper or a computer screen.

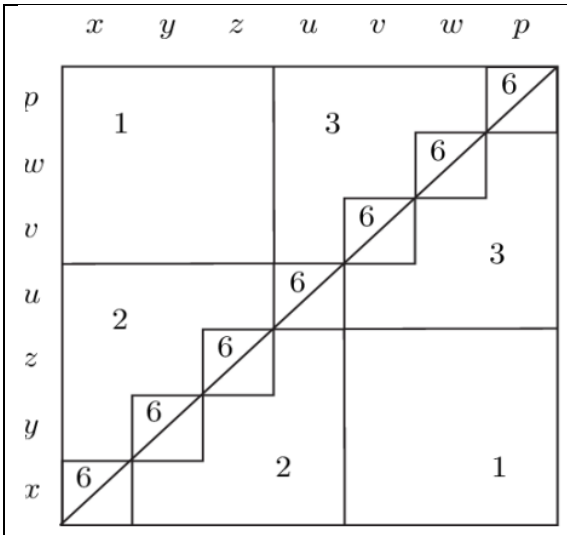
Types of index map are:

- ✓ **Plots map** : A plat map, also known as a "plat," shows you how a tract of land is divided into lots in your county. It is drawn to scale and records the land's size, boundary locations, nearby streets, flood zones, and any easements or rights of way.

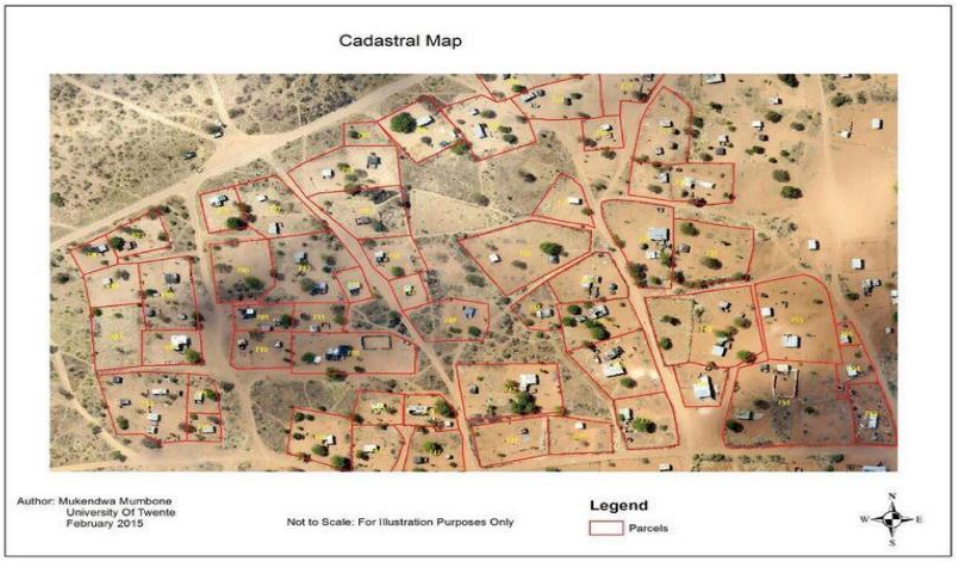


- ✓ **Attribute files of the Cadastre**: Spatial data are stored in a file or files according to a GIS software developer' s definition and attributes are stored in a relational database, and the storage style.

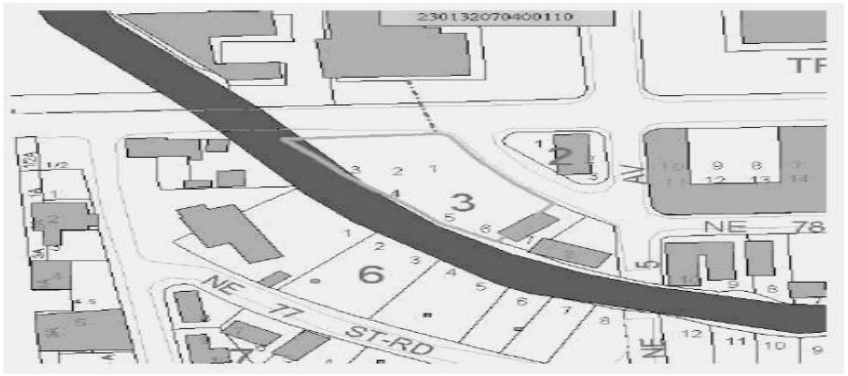
- ✓ **Graphical indices** : A topological index is a real number related to a graph, that must be a structural invariant.



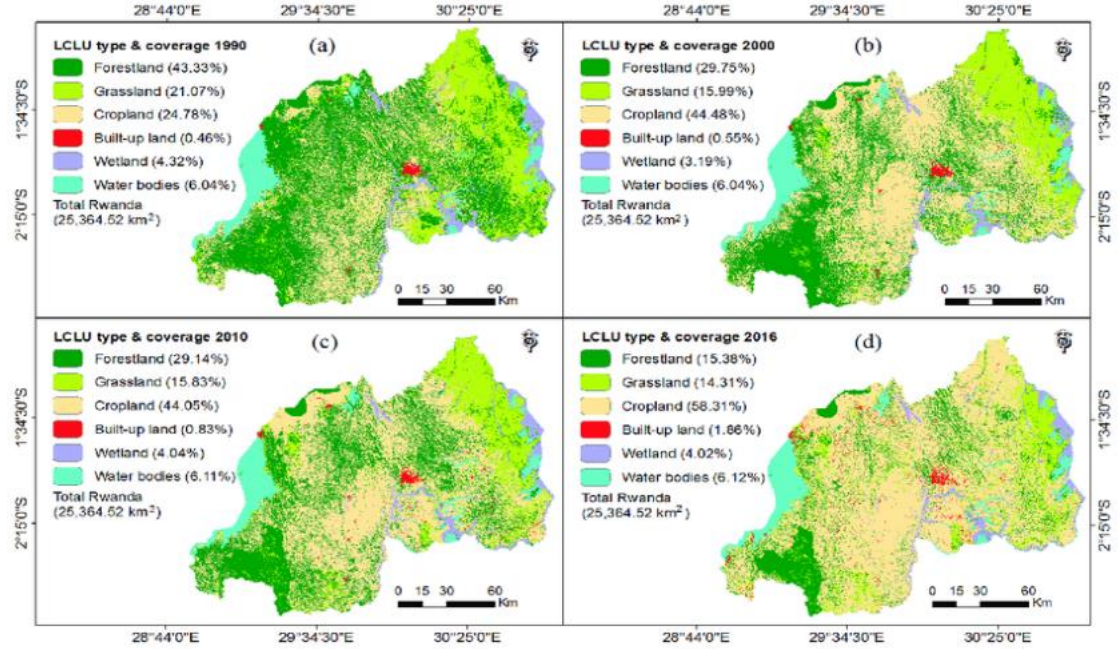
- ✓ **Cadastral maps :** A large-scale map showing the boundaries of subdivisions of land, usually with the directions and lengths thereof and the areas of individual tracts, compiled for the purpose of describing and recording ownership.



- ✓ **Land taxes map:** Tax Map is an electronic or written document detailing the size and value of a piece of taxable real estate, among other information. A tax map may be useful to a potential buyer. Written tax maps are kept in the local tax office.



- ✓ **Land use maps**: land use map: A map that shows the types and intensities of different land uses in a particular area.



Content 2.4.2: Use of index maps

Uses of index map are:

- ✓ Taxation
- ✓ Valuation
- ✓ Multipurpose cadastral
- ✓ Construction permit

Theoretical learning Activity

- ✓ Group discussion on types of index maps
- ✓ Brainstorm on creating a cadastral map from and ortho photo

Practical learning Activity

- Trainees to produce a cadastral base map in ArcGIS

Points to Remember (Take home message)

✓ What is an index map ✓ Types of index maps

Learning outcome 2.4 formative assessment

1. Define the term "index map"?
2. State four (4) uses of index map
3. What are the different types of an index map ?

Answers

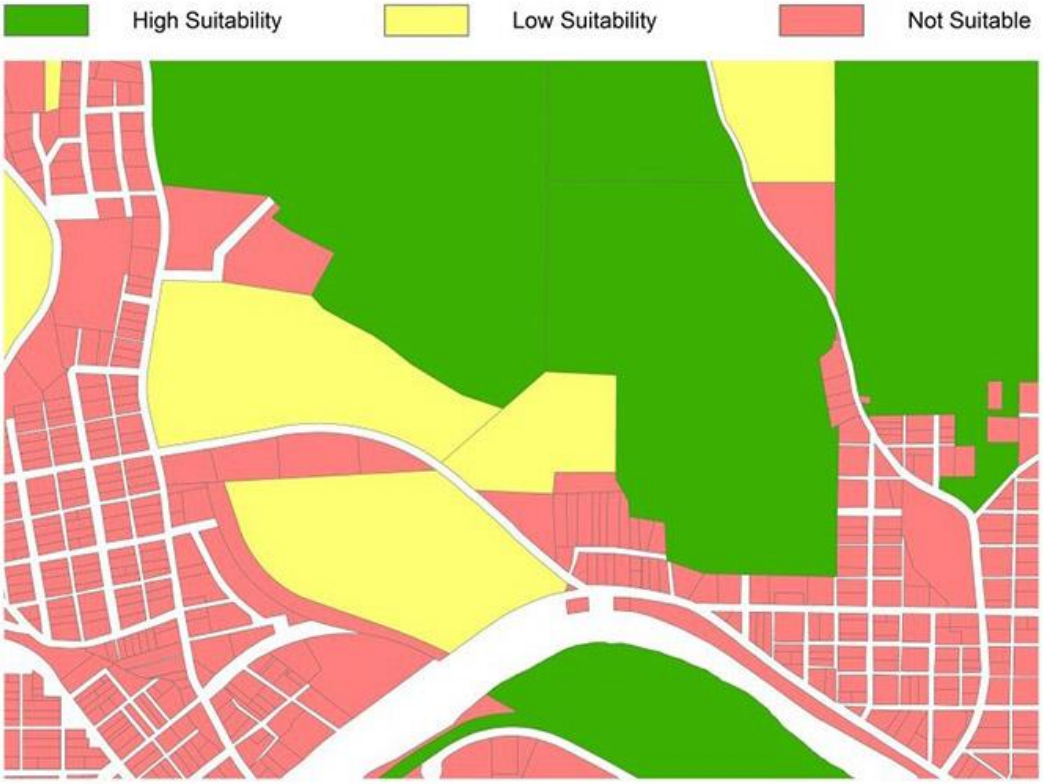
1. **Index map:** Index map is a type of finding aid that enables users to find a set of maps covering their regions of interest along with the name or number of the relevant map sheet. An index map provides geospatial data on either a sheet of paper or a computer screen

2. **Uses of index map are:**

- **Taxation**
- **Valuation**
- **Multipurpose cadastral**
- **Construction permit**

3. Types of an index map

- **Plots map**
- **Attribute files of the Cadastre**
- **Graphical indices**
- **Cadastral maps**
- **Land taxes map**



Source : [Land use planning and spatial land use planning as a sub-set | Download Scientific Diagram (researchgate.net)]

STRUCTURE OF LEARNING UNIT 3

Learning outcomes:

3.1 Identify the methods/tools for land use planning

3.2 Produce Land use plan

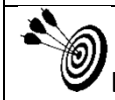
3.3 Produce a physical plan

3.4 Produce simple master plan

3.5 Produce zoning map

Learning outcome 3.1 Identify the methods/tools for land use planning

 **Duration: 3hrs**

 Learning outcome 3.1 objectives :

By the end of the learning outcome, the trainees will be able to:

1.identify the types of land use planning

2. know the steps for land use planning

3. identify the methods used for land use planning

4.identify tools for land use planning.

 **Resources**

Equipment	Tools	Materials
• Projector • Computer • Workshop • GIS Lab	• Whiteboard/ Black board • GIS data • Land use map • ArcGIS software	• Book • Notebook • Pen • Marker pen • Chalks

 **Advance preparation:**

- Having prepared the working place.

- Having arranged tools, equipment and materials according to the task to be performed.
- Having made trainee's groups in order to facilitate them to work properly

Content 3.1.1: Methods of land use planning

Introduction

The Rwanda urbanization faces the following problems:

- weakness in urban planning and in implementation of planning tools;
- weak urban infrastructure;
- uncoordinated management of human settlements;
- limited financing resource **(RWANDA ENVIRONMENTAL POLICY, 2003)**

- **Land-use planning** is the process of regulating the use of land in an effort to promote more desirable social and environmental outcomes as well as a more efficient use of resources.
- **The main Types of Land Use**
  - Recreational,
  - Transportation,
  - Agricultural,
  - Residential,
  - Commercial.
- **The steps of producing land use planning**
  1. The goals and tems of references
  2. Organise the wok
  3. Analyse the problems
  4. Identify opportunities for change
  5. Evaluate land suitability
  6. Appraise the alternatives : environmental, economics and social analysis
  7. Choose the best options
  8. Prepare the land use plan
  9. Implement the plan
  10. Monitor and revise the plan
- **The benefits of land use planning are:**
  - Environmental protection,
  - Avoidance of urban sprawl,
  - Departure from impacts of transportation,
  - Promotion of compatible uses,
  - Public health and safety considerations.

- Etc

- **Methods used to produce land use planning**

✓ **Land evaluation**: Land Valuation is the technique of estimating and determining the fair price or value of a land parcel.

✓ **Agro Ecological Zoning**: An Agro-ecological Zone is a land resource mapping unit, defined in terms of climate, landform and soils, and/or land cover, and having a specific range of potentials and constraints for land use.

✓ **Farming System Analysis**: A farming system includes all components (cropland, cropping systems and livestock, common grazing land and woodlots managed by several farmers in a community and off-farm activities) of a farm enterprise, within a framework of markets for land, labour, production inputs, farm products, credit and knowledge.

✓ **Participatory approaches**: A participatory approach is an approach in which the end users of a sanitation or water system are involved in the planning of the system from the start.(FAO, 1996)

Content 3.1.2: Tools of land use plan

✓ **Spatial planning:** Spatial planning can be defined as the coordination of practices and policies affecting spatial organization.

✓ **Zoning**: Zoning is the process of dividing land in a municipality into zones (e.g. residential, industrial) in which certain land uses are permitted or prohibited.

✓ **Master plan:** A master plan is a dynamic long-term planning document that provides a conceptual layout to guide future growth and development. Master planning is about making the connection between buildings, social settings, and their surrounding environments**.**

✓ **Local development plan:** The Local Development Plan (LDP) guides development within the municipality. sets out the long-term future for the municipality. outlines how we'll ensure that growth is delivered in the right places. guides how the growth will take into account the needs of our local communities.

✓ **Environment Impact Assessment** (EIA): The systematic evaluation of a project to determine its impact on the environment and natural resources. EIA is a systematic, reproducible and multilevel process of identification, prediction and analysis of significant environmental impacts (positive or negative) of a proposed project or activity and its practical alternatives on the physical, biological, cultural and socio-economic characteristics of a particular geographic area in order to provide information necessary for enhancing decision making (MINISTRY OF LANDS, 2003).

The Organic Law (No. 04/2005 of 08/04/2005) (Article 67) requires that projects, programmes and policies that may affect the environment shall be subjected to

environmental impact assessment before obtaining authorisation for implementation. Article 69 gives REMA legal authority to oversee the conduct of EIA.

At a minimum, a Project Brief submitted to the Authority shall contain the following information:

i) Name, title and address of developer.
ii) Name, purpose, objectives and nature of project, including attributes such as size of project, design, activities that shall be undertaken during and after the establishment of the project, products and inputs, sources of inputs, etc.
iii) Description of the proposed project site and its surroundings and alternative sites, if any, where the project is to be located.
iv) Description of how the proposed project and its location conform to existing laws, regulations and policies governing such project and the use of the site/area proposed for its location.
v) Any likely environmental impacts that may arise due to implementing various phases/stages of the project and proposed mitigation measures thereto.
vi) Description of any other alternatives, which are being considered (e.g. siting, technology, construction and operation procedures, sources of raw materials, handling of wastes etc., decommissioning/closure and site restoration).
vii) Any other information that may be useful in determining the level of EIA required (REMA, 2006).

Generally, benefits of EIA are;

i) Enabling incorporation of environmental considerations in design and site selection for a project or development activities.
ii) Providing information beneficial to decision making.
iii) Enhancing responsibilities of relevant parties in the development process.
iv) Mitigating and minimizing environmental damage.
v) Avoiding costs and delays in implementation of projects that would arise from unanticipated environmental problems.
vi) Making development projects more financially and economically efficient.
vii) Making an active contribution to sustainable development.

Challenges of EIA in Rwanda

Insufficient enforcement of EIA and EA related laws still remain a major issue of concern in Rwanda's environment and natural resources sector.(Ministry of Environment, 2019;)


Theoretical learning Activity

- ✓ Group discussion on methods and tools of land use plan
- ✓ Brainstorm on factors to consider when valuing land


Points to Remember (Take home message)

- ✓ benefits of land use planning
- ✓ steps of producing land use planning

- ✓ types of zoning
- ✓ EIA

Learning outcome 3.1 formative assessment

1. State 5 benefits of doing an EIA

2. Explain the term participatory approach used as a method of producing land use plan

Answers

1. Benefits of EIA are;
   - **Enabling incorporation of environmental considerations in design and site selection for a project or development activities.**
   - **Providing information beneficial to decision making.**
   - **Enhancing responsibilities of relevant parties in the development process.**
   - **Mitigating and minimizing environmental damage.**
   - **Avoiding costs and delays in implementation of projects that would arise from unanticipated environmental problems.**
   - **Making development projects more financially and economically efficient.**
   - **Making an active contribution to sustainable development**
2. **Participatory approaches**: A participatory approach is an approach in which the end users of a sanitation or water system are involved in the planning of the system from the start

Learning outcome 3.2 Produce Land use plan

Duration: 5hrs

Learning outcome 3.2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify the elements of land use planning
2. Identify the categories of land use planning
3. Identify the types of land use plan

Resources

Equipment	Tools	Materials
• Projector • Computer • GIS Lab	• Whiteboard/ Black board • GIS data • Printed Land use map • ArcGIS software	• Book • Notebook • Pen • Marker pen • Chalks

Advance preparation:

- Prepare the working place (GIS Lab/computer lab).
- Arrange tools, equipment and materials according to the task to be performed.
- Having made trainee's groups in order to facilitate them to work properly

Content 3.2.1 Land use plan content

- ✓ **Executive summary**: An executive summary provides an overview of a larger document or research and is usually the first thing your reader will see.

  Executive summaries will analyze a problem, drawn conclusions, and recommend a course of action in a complete but brief synopsis.

  An executive summary should summarize the key points of the report. It should restate the purpose of the report, highlight the major points of the report, and describe any results, conclusions, or recommendations from the report.

- ✓ **Terms of reference**: A Terms of Reference (TOR), describes the purpose and objectives of, in this case, a project Environmental Impact Assessment (EIA). Prepared by the Physical Planning Division, the TOR sets the objectives, defines the scope and establishes the strategy and schedule for the EIA process.

- ✓ **Land-use problems:** To define a problem it is necessary to establish the present situation, judge ways in which it is unsatisfactory and identify ways in which it might be made better. Apart from when planning new settlements on unoccupied land, this stage of diagnosis of problems is of the highest importance.

  Example: Agricultural land use may also result in loss of native habitats or increased wind erosion and dust, exposing humans to particulate matter and various chemicals.

- ✓ **Land-use types and management:** There are many different categories when it comes to land use. The five most common uses are recreational, transport, agricultural, residential and commercial. ... Agricultural land is used for the growing and harvesting of crops and livestock. These are things like ranches, farms and pastures.

  Land management is the process of managing the use and development (in both urban and rural settings) of land resources.

  In short, land use management is a system that ensures that the right things get built, in the right place, at the right time. The system consists of legal requirements and regulations that ensure that land is developed in a desirable and sustainable way.

- ✓ **Land suitability:** Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvements. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for defined uses.

- ✓ **Appraisal of alternatives:** Appraise the alternatives: environmental, economic and social analysis. The evaluation carried out so far has been essentially in terms of physical suitability. An assessment has been made of whether different kinds of land use can be undertaken on a sustained basis.

- ✓ **Recommended changes in land use:** Land use change simply refers to the conversion of a piece of land's use by humans, from one purpose to another. For example, land may be converted from cropland to grassland, or from wild land to human-specific land uses. The change in land use is needed because Land use change is associated with a variety of positive and negative outcomes for society and the environment. From society's point of view, land use change is essential to produce food, feed, and fiber for human use, as well as to provide habitable space for people.

- ✓ **The land-use plan development:** Land-use planning is the process of regulating the use of land in an effort to promote more ... Governments use land use planning to manage the development of land within their jurisdictions

- ✓ **Implementation of the plan:** Implementation is the carrying out, execution, or practice of a plan, a method, or any design, idea, model, specification, standard or policy for doing something. As such, implementation is the action that must follow any preliminary thinking in order for something to actually happen.

  - Process of implement land use plans
    - Establish goals and terms of reference.
    - Organize the work.
    - Analyse the problems.
    - Identify opportunities for change.
    - Evaluate land suitability.
    - Appraise the alternatives: environmental, economic and social analysis.
    - Choose the best option.
    - Prepare the land-use plan.
    - Implement the plan
    - Monitor and Revise the plan

- ✓ Procedures for monitoring and revision. Now the planning process comes full circle. Information is needed on how well the plan is being implemented and whether it is succeeding, so that the implementation agencies can improve the way in which the plan is being applied and so that the planning team may learn from experience and respond to changing conditions. It is necessary to know:
  - Are the land-use activities being carried out as planned?
  - Are the effects as predicted?
  - Are the costs as predicted?
  - Have the assumptions on which the plan was based proved to be correct?
  - Are the goals still valid?
  - How far are the goals being achieved?

- ✓ **Supporting information:** The term "supporting details" can be defined as additional information that explains, defines or proves an idea. Supporting information means

documentation and information reasonably necessary to verify the calculation or determination for which such documentation and information is requested or provided

Content 3.2.2 Land use plan types

- ✓ **Site plan**: A site plan is a large-scale drawing that shows the full extent of the site for an existing or proposed development.
- ✓ **Sector plan:** A Sector Plan is a long-range plan for a specific geographic area of at least 15,000 acres in one or more local governmental jurisdictions.
- ✓ **Structure plan:** A Structure Plan is a planning document which provides for the coordination of the future subdivision and development of a defined area.
- ✓ **Land use map:** Land use refers to the purpose the land serves, for example, recreation, wildlife habitat or agriculture; it does not describe the surface cover on the ground. Land use map: are maps created to represent the potential uses of a "unit" of land.
- ✓ **Land cover map**: Land cover maps represent spatial information on different types (classes) of physical coverage of the Earth's surface, e.g. forests, grasslands, croplands, lakes, wetlands


Theoretical learning Activity

- ✓ Group discussion on various land use problems
- ✓ Brainstorm on land use types and content


Points to Remember (Take home message)

- ✓ Process of implementing land use plans
- ✓ Land use plan types

Learning outcome 3.2 formative assessment

1. Distinguish the five (5) types of land use plan.
2. List in chronological order the land use implementation process.

Answers

1. Types of land use plan
   - **Site plan**:
   - **Sector plan**
   - **Structure plan**
   - **Land cover map**
   - **Land use map**
2. Process of implement land use plans
   - **Establish goals and terms of reference.**
   - **Organize the work.**
   - **Analyse the problems.**
   - **Identify opportunities for change.**
   - **Evaluate land suitability.**
   - **Appraise the alternatives: environmental, economic and social analysis.**
   - **Choose the best option.**
   - **Prepare the land-use plan.**
   - **Implement the plan**
   - **Monitor and Revise the plan**

Learning outcome 3.3 Produce a physical plan

Duration: 8hrs

Learning outcome 3.3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Know the meaning of physical plan
2. Identify the elements of physical plan
3. Know how to produce a physical plan

Resources

Equipment	Tools	Materials
• Projector • Computer • GIS Lab	• Whiteboard/ Black board • GIS data • Land use map • ArcGIS software	• Book • Notebook • Pen • Marker pen • Chalks

Advance preparation:

prepared the working place.

- Prepare the working place (GIS Lab/computer lab).
- Arrange tools, equipment and materials according to the task to be performed.
- Having made trainee's groups in order to facilitate them to work properly

Content 3.3 Physical plan content/elements

- ✓ **Plots standard**: plot is a tract or parcel of land owned or meant to be owned by some owner(s).
- ✓ **Housing design** : It can be defined as the design of dwelling structures with an understanding of the prospective development of the site as well as life and social scenarios, and with the possibility of making appropriate changes in the living environment.
- ✓ **Roads**: is a wide way leading from one place to another, especially one with a specially prepared surface which vehicles can use.
- ✓ **Water**: Water is a liquid found on Earth which is known as H20 that has no odour or taste. · Seventy percent of the earth is made up of water.
- ✓ **Electricity**: It is a form of energy resulting from the existence of charged particles (such as electrons or protons), either statically as an accumulation of charge or dynamically as a current.
- ✓ **Plots dimension**: The size of a plot can be measured using a variety of different units such as acres, hectares, square feet or square metres. These units fall under two international standards of measurement: Imperial (feet, acres) and metric (meters, hectares).
- ✓ **Plot layout**: A plot plan is an architecture, engineering, and/or landscape architecture plan drawing diagram which shows the buildings, utility runs, and equipment layout, the position of roads, and other constructions of an existing or proposed project site at a defined scale. Plot plans are also known more commonly as site plans

Figure 2. – showing digitized features

Source (Chiemelu & Eze, 2014)

 Theoretical learning Activity

✓ Group discussion on elements of Physical plan

 Points to Remember (Take home message)

✓ elements of Physical plan

 **Learning outcome 3.3 formative assessment**

1. Explain the term **"**physical plan**"**
2. List seven (7) elements of a physical plan

Answer:

1. "Physical plan" refers to a set of actions aimed at improving the physical, social and economic welfare of a place and its dwellers.
2. elements of a physical plan
    - **Plots standard**
    - **Housing design**
    - **Roads**
    - **Water:**
    - **Electricity**
    - **Plots dimension**
    - **Plot layout**:

Learning outcome: 3.4: Produce simple master plan

Duration: 7hrs

Learning outcome 3.4 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Describe the elements of master plan
2. Describe the component of master plan

Resources

Equipment	Tools	Materials
• Projector • Computer • GIS Lab	• Whiteboard/ Black board • GIS data • Land use map • ArcGIS software	• Book • Notebook • Pen • Marker pen • Chalks

Advance preparation:

- Prepare the working place (GIS Lab/computer lab).
- Arrange tools, equipment and materials according to the task to be performed.
- Having made trainee's groups in order to facilitate them to work properly

Content 3.4.1. Master plan components

Master planning is a type of urban planning that pertains to the physical development of a city or town over the long term, usually covering a time frame of about 10 to 15 years into the future. It is intended to guide a community's growth from a high-level perspective, focusing on ways to:

- Preserve a locality's unique character

- Ensure diversity
- Support investment
- Promote desired change
- Enhance a community's liability

Master plan components

✓ **The Strategic Framework: A** strategic framework is a structured method used to define how a project or initiative supports the key objectives of stakeholders**.**

✓ **The Spatial Master plan**: It can be defined as the coordination of practices and policies affecting spatial organization.

✓ **Implementation Plan:** Implementation Plan Used as a support device for your strategic plan, an implementation plan maps out how to bring your strategic plan to life by breaking it into identifiable steps, where each step is assigned a to team member to complete on a set timeline.

Content 3.4.2. Master plan elements/features

✓ **Housing layout**: Housing layout design is defined as a design to allocate many house-units in the undeveloped site.

✓ **Housing design:** It can be defined as the design of dwelling structures with an understanding of the prospective development of the site as well as life and social scenarios, and with the possibility of making appropriate changes in the living environment.

✓ **Roads:** It is a wide way leading from one place to another, especially one with a specially prepared surface which vehicles can use.

✓ **Water:** Water is a liquid found on Earth which is known as H20 that has no odor or taste. · Seventy percent of the earth is made up of water.

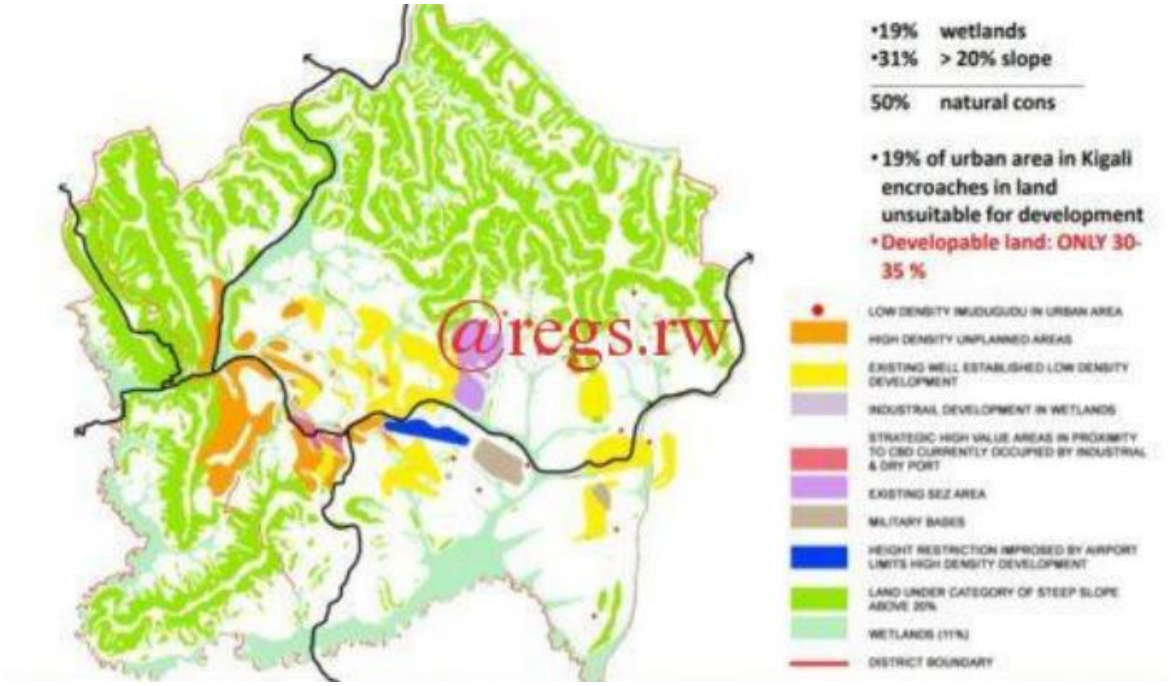
✓ **Electricity**: It is a form of energy resulting from the existence of charged particles (such as electrons or protons), either statically as an accumulation of charge or dynamically as a current.

✓ **Plots dimension**: The size of a plot can be measured using a variety of different units such as acres, hectares, square feet or square metres. These units fall under two international standards of measurement: Imperial (feet, acres) and metric (meters, hectares).

✓ **Open space:** Open space is any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public. Open space can include: green space (land that is partly or completely covered with grass, trees, shrubs, or other vegetation).

- ✓ **Recreation**: Recreational areas would include land that is designed, constructed, designated, or used for recreational activities
- ✓ **Population pattern**: It means the pattern of where people live.
- ✓ **Transport:** Transport, or transportation, is the movement of humans, animals and goods from one location to another.
- ✓ **building height:** The building height is the vertical distance between finished grade and the highest point on the building, provided that the measured elevation does not include fill or berms.
- ✓ **Facilities location:** is the right location for the manufacturing facility, it will have sufficient access to the customers, workers, transportation, etc.
- ✓ **Services location**: means the structures, facilities, or improvements on a parcel of real property to which electric service may be provided.
- ✓ **Utilities location**: Utility location is the process of identifying and labeling public utility mains that are underground.
- ✓ **Amenities:** Is a desirable or useful feature or facility of a building or place. Amenity is any feature that provides comfort, convenience, or pleasure: The house has a swimming pool, two fireplaces, and other amenities.

A master plan includes: Analysis, recommendations, and proposals for a site's population, economy, housing, transportation, community facilities, and land use (World bank, 2015).



Each Master Plan may specify the revision procedures, approval process, and define what types of modifications qualify as a revision. Revisions may consist of such items as **typographical errors**, **measurement errors** or **boundary adjustments** as allowed by the Plan. Revisions should comply with the requirements and intent of the Plan, and shall not

change the basic configuration or intent of the Plan. You need a plan that looks out 10 to 15 years to maintain consistency in growth over time.

 Theoretical learning Activity

✓ Group discussion on importance of master plan elements and features

 Practical learning Activity

✓ Create a sample master plan of your school

 Points to Remember (Take home message)

- Master Plan Elements

 **Learning outcome 3.4 formative assessment**

Discuss any ten (10) master plan elements

Answer

Ten (10) master plan elements

- **Housing layout**
- **Roads**
- **Electricity**
- **Open space**
- **Population pattern**
- **building height**
- **Services location**
- **Amenities**

Housing design
Water
Plots dimension
Recreation:
Transport
Facilities location:
Utilities location

Learning outcome: 3.5: Produce zoning map

Duration: 7hrs

Learning outcome 3.5 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify area zoning components
2. Produce zoning map

Resources

Equipment	Tools	Materials
• Projector • Computer • GIS Lab	• Whiteboard/ Black board • GIS data • Land use map • ArcGIS software	• Book • Notebook • Pen • Marker pen • Chalks

Advance preparation:

- Prepare the working place (GIS Lab/computer lab).
- Arrange tools, equipment and materials according to the task to be performed.
- Having made trainee's groups in order to facilitate them to work properly

Content 3. 5 Zoning area

While land use and zoning are intrinsically tied together, they are two completely different terms with separate definitions.

Zoning Laws: are designed to regulate and restrict how a piece of land can be used based on the land's location relative to other zones that have been created. How the land is zoned also depends on how the province is zoned. If you've never been involved with zoning before, this is easily the most common land use regulation that's used by authorities to control how land is developed within their borders.

Types of Zoning

When city planners map out the city plan, they characterize each land zone and this affects urban development. There are four types of land planning and land use zoning:

a. **Functional Zoning** – The seven types of zones outlined above are an example of functional zoning. Each zone is defined according to their function – commercial, residential, industrial, etc. Each has rules and regulations about the types of buildings and activities that can be built.

b. **Form-based Zoning** – This is zoning based upon physical characteristics or urban identity. Think of "downtown" areas.

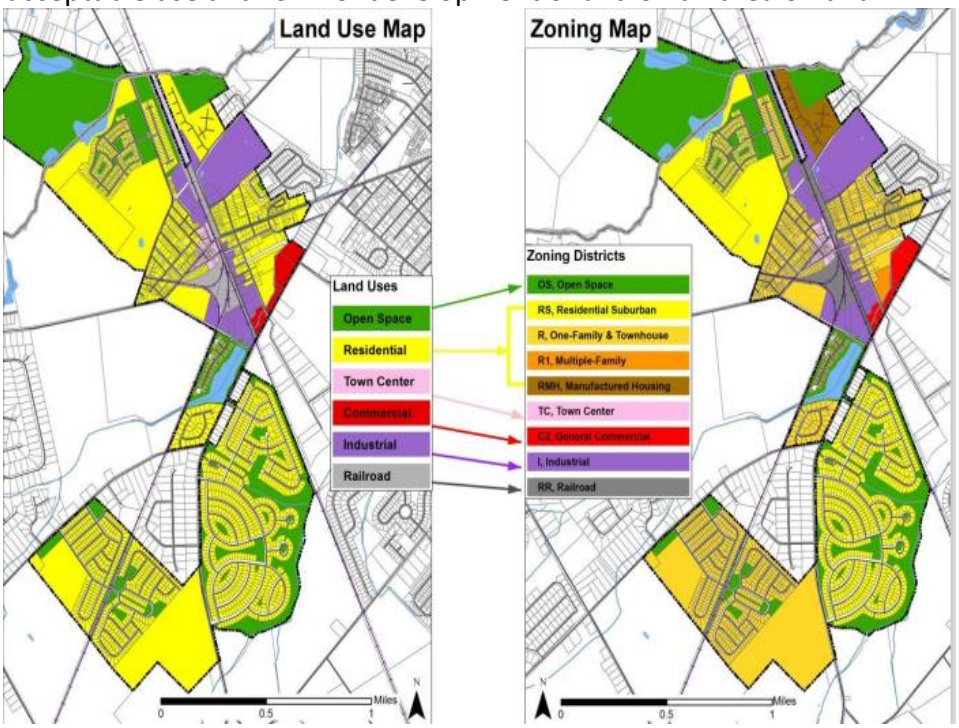
c. **Intensity Zoning** – Defined by level of permitted intensity. Reflect back on the residential land use that is split between high, medium, and low density housing. This is an example of intensity zoning where a certain number of residential units are allowed per unit of surface.

d. **Incentive Zoning** – Economically depressed areas are often part of revitalization or development plans and developers are incentivized to build new buildings and areas through tax abatements or infrastructures such as light rail.

Zoning area components are

- ✓ **Residential area**: A residential area is a land use in which housing predominates, as opposed to industrial and commercial areas.
- ✓ **Commercial area**: A commercial area is real estate intended for use by for-profit businesses, such as office complexes, shopping malls, service stations and restaurants.
- ✓ **Agricultural area**: Agricultural land is defined as the land area that is either arable, under permanent crops, or under permanent pastures.
- ✓ **Education area**: areas are one method that schools use to organize knowledge, teaching, and academic programming.
- ✓ **Industrial area**: an area outside of a town or city that is designed especially for factories or offices.

- ✓ **Forest area**: Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.
- ✓ **Recreation area:** Recreational areas would include land that is designed, constructed, designated, or used for recreational activities. Examples are national, state, county, or city parks, other outdoor recreational areas such as golf courses or swimming pools and bodies of waters (oceans, lakes, rivers, and streams) when used by the public for fishing, swimming, or boating.
- ✓ **Rural zoning:** Zoning is a tool used by planners and planning authorities to prescribe the acceptable use and form of development of and on an area of land.



- ✓ **Historic zoning:** Historic zoning is a zoning overlay which is added to the base zoning of a specific tract of land (for example CBD-H denotes Central Business District-Historic Zoning).
- ✓ **Aesthetic zoning:** Aesthetic zoning means a zoning in which, zoning regulations such as conformity to architectural and landscaping requirements are imposed to preserve the aesthetic features or values of an area.

The advantages of zoning

- ➢ It can prevent the mixing of incompatible land uses (such as erotic dance clubs and schools).
- ➢ It can allow potential nuisance uses to be located away from residential neighbourhoods or other sensitive areas.
- ➢ It can provide for better lot arrangement.
- ➢ It can protect recreational areas and open space.


Theoretical learning Activity

- ✓ Group discussion on types of land use zoning


Points to Remember (Take home message)

- ✓ Zoning laws
- ✓ **Z**oning area components


Learning outcome 3.5 formative assessment

1. Outline any four (4) components of zoning area.
2. Define the term zoning
3. List four (4) types of zoning

Answers

1. Components of zoning area:
   - **Residential area**
   - **Commercial area**
   - **Agricultural area**
   - **Education area**
   - **Industrial area**
   - **Forest area**
   - **Recreation area**
   - **Rural zoning**
   - **Historic zoning:**
   - **Aesthetic zoning**

2. Zoning is the process of dividing land in a municipality into zones (e.g. residential, industrial) in which certain land uses are permitted or prohibited
3. four (4) types of zoning
   - **Functional zoning:** It include
   - **Form Based Zoning:**
   - **Intensity Zoning**
   - **Incentive Zoning:**

SUMMATIVE ASSESSMENT

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